



Aerospace Medicine  
and Biology  
A Continuing  
Bibliography  
with Indexes

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(NASA-SP-7011(313)) AEROSPACE MEDICINE AND  
BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH  
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## ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

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# **AEROSPACE MEDICINE AND BIOLOGY**

## **A CONTINUING BIBLIOGRAPHY WITH INDEXES**

**(Supplement 313)**

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in July 1988 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



Scientific and Technical Information Division 1988  
National Aeronautics and Space Administration  
Washington, DC

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# INTRODUCTION

This Supplement to *Aerospace Medicine and Biology* lists 227 reports, articles and other documents announced during July 1988 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of the bibliography was published in July 1964.

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects of biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

An annual index will be prepared at the end of the calendar year covering all documents listed in the 1988 Supplements.

Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

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## TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER	→	<b>N88-10483*</b>	Texas Univ., Houston. Health Science Center.	←	CORPORATE SOURCE
TITLE	→	<b>PREVENTION OF DISUSE OSTEOPOROSIS: EFFECT OF SODIUM FLUORIDE DURING FIVE WEEKS OF BED REST Final Report</b>			←
AUTHOR	→	VICTOR S. SCHNEIDER	Oct. 1987	64 p	← PUBLICATION DATE
REPORT NUMBERS	→	(Contract NAS9-16688) (NASA-CR-172018; NAS 1.26:172018) Avail: NTIS HC A04/MF			← AVAILABILITY SOURCE
COSATI CODE	→	A01	CSCL 06E		← PRICE CODE

An attempt was made to modify factors which promote disuse osteoporosis and thereby prevent it from occurring. Since fluoride is currently used to enhance bone formation in the treatment of low turnover osteoporosis, it was hypothesized that if the fluoride ion was available over a long period of time that it would slow the demonstrated loss of calcium by inhibiting bone resorption and enhancing bone formation. This study was used to determine whether oral medication with sodium F will modify or prevent 5 weeks of bed rest induced disuse osteoporosis, to determine the longitudinal effects of 5 weeks of bed rest on PTH, CT and calcitriol, to measure muscle volume changes and metabolic activity by magnetic resonance imaging and magnetic resonance spectroscopy during prolonged bed rest, to measure changes in peak muscle strength and fatigability, and to measure bone turnover in bone biopsies. Subjects were studied during 1 week of equilibration, 4 weeks of control ambulation, 5 weeks of bed rest, and 1 week of reambulation.

E.R.

## TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED  
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ACCESSION NUMBER	→	<b>A88-12321*</b>	National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.	
TITLE	→	<b>CONTINUOUS MONITORING OF BLOOD VOLUME CHANGES IN HUMANS</b>		
AUTHORS	→	H. HINGHOFER-SZALKAY and J. E. GREENLEAF (NASA, Ames Research Center, Moffett Field, CA; Graz, Universitaet, Austria)	←	AUTHOR'S AFFILIATION
JOURNAL TITLE	→	Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Sept. 1987, p. 1003-1007. Research supported by the Oesterreichische Akademie der Wissenschaften. refs (Contract NASA TASK 199-21-12-07)	←	PUBLICATION DATE

Use of on-line high-precision mass densitometry for the continuous monitoring of blood volume changes in humans was demonstrated by recording short-term blood volume alterations produced by changes in body position. The mass density of antecubital venous blood was measured continuously for 80 min per session with 0.1 g/l precision at a flow rate of 1.5 ml/min. Additional discrete plasma density and hematocrit measurements gave linear relations between all possible combinations of blood density, plasma density, and hematocrit. Transient filtration phenomena were revealed that are not amenable to discontinuous measurements.

I.S.



# AEROSPACE MEDICINE AND BIOLOGY

*A Continuing Bibliography (Suppl. 313)*

AUGUST 1988

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## LIFE SCIENCES (GENERAL)

**A88-32802\*** Arizona Univ., Tucson.

### GLUCOSE UPTAKE IN RAT SOLEUS - EFFECT OF ACUTE UNLOADING AND SUBSEQUENT RELOADING

ERIC J. HENRIKSEN and MARC E. TISCHLER (Arizona, University, Tucson) *Journal of Applied Physiology* (ISSN 0161-7567), vol. 64, April 1988, p. 1428-1432. refs  
(Contract NAG2-384)

The effect of acutely reduced weight bearing (unloading) on the in vitro uptake of 2-1,2-H-3-deoxy-D-glucose was studied in the soleus muscle by tail casting and suspending rats. After just 4 h, the uptake of 2-deoxy-D-glucose fell (-19 percent) and declined further after an additional 20 h of unloading. This diminution at 24 h was associated with slower oxidation of C-14-glucose and incorporation of C-14-glucose into glycogen. At 3 days of unloading, basal uptake of 2-deoxy-D-glucose did not differ from control. Reloading of the soleus after 1 or 3 days of unloading increased uptake of 2-deoxy-D-glucose above control and returned it to normal within 6 h and 4 days, respectively. These effects of unloading and recovery were caused by local changes in the soleus, because the extensor digitorum longus from the same hindlimbs did not display any alterations in uptake of 2-deoxy-D-glucose or metabolism of glucose. Author

**A88-32833\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### SIMULATED ANNEALING IN NETWORKS FOR COMPUTING POSSIBLE ARRANGEMENTS FOR RED AND GREEN CONES

ALBERT J. AHUMADA, JR. (NASA, Ames Research Center, Moffett Field, CA) IN: IEEE Annual International Conference on Neural Networks, 1st, San Diego, CA, June 21-24, 1987, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. IV-107 to IV-114. refs

Attention is given to network models in which each of the cones of the retina is given a provisional color at random, and then the cones are allowed to determine the colors of their neighbors through an iterative process. A symmetric-structure spin-glass model has allowed arrays to be generated from completely random arrangements of red and green to arrays with approximately as much disorder as the parafoveal cones. Simulated annealing has also been added to the process in an attempt to generate color arrangements with greater regularity and hence more revealing moiré patterns than than the arrangements yielded by quenched spin-glass processes. Attention is given to the perceptual implications of these results. O.C.

**A88-33579**

### EFFECTS OF CHRONIC HYPEROXIA ON THE CARDIOVASCULAR RESPONSES TO VASOACTIVE COMPOUNDS IN THE RABBIT

JEFFREY C. SVENTEK and EDWARD J. ZAMBRASKI (Rutgers State University, New Brunswick, NJ) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 59, April 1988, p.

314-320. Research supported by the Carl N. Steinetz Memorial Fund. refs

(Contract NIH-HL-25255)

The effect of chronic hyperoxia (98 percent oxygen) on the pulmonary prostaglandin dehydrogenase/reductase and angiotensin-converting enzymes (ACEs) was evaluated in rabbits by measuring changes in the peripheral vascular responses to exogenous prostaglandin and angiotensin. The experimental and control rabbits were given bolus injections of angiotensin I and II (Ang I and II, respectively), prostaglandin E2 (PGE2), sodium nitroprusside (NP), or phenylephrine (PE) before and during the 88-h-long oxygen or air exposure. The results indicate that the ability of cardiovascular system to respond to PE, NP, PGE2 remains intact during chronic oxygen exposure. Chronic hyperoxia caused a reduced systemic mean arterial pressure response to both Ang I and Ang II, providing indirect evidence for ACE disruption and/or systemic Ang II receptor degradation. I.S.

**A88-33585**

### PROPHYLACTIC CORTICOSTEROID INCREASES SURVIVAL IN EXPERIMENTAL HEAT STROKE IN PRIMATES

P. GATHIRAM, M. T. WELLS, J. G. BROCK-UTNE, and S. L. GAFFIN (Natal Medical School, Durban, Republic of South Africa) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 59, April 1988, p. 352-355. refs

**A88-33588**

### INTRAMUSCULAR AND INTRAVENOUS ATROPINE - COMPARISON OF EFFECTS IN THE HEAT-STRESSED RAT

CANDACE B. MATTHEW, GLENN J. THOMAS, ROGER W. HUBBARD, and RALPH P. FRANCESCONI (U.S. Army, Research Institute of Environmental Medicine, Natick, MA) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 59, April 1988, p. 367-370. refs

The role of the route of atropine administration on the response of heat-stressed (41.5 C) rats was investigated in animals injected with 10-4000 microg/kg doses of atropine intramuscularly (im) or intravenously (iv). Heating rate (as quantified by the rise of core temperature) was found to be identical for both routes of administration, but the range of doses over which there was a linear dose-response effect on heating rate was markedly truncated in the case of the im route as compared with the iv route (10-150 microg/kg vs 10-1000 microg/kg range, respectively). Both the im- and iv-injected atropine had similar effects on weight loss rate and mydriasis, but the iv route produced the most consistent results and more sensitive physiological response over a wider dose range, indicating that it is a preferable route of administration. I.S.

**A88-33590**

### A NEW TECHNIQUE FOR ILIAC CREST BIOPSY IN RHESUS MONKEYS FOR USE IN WEIGHTLESSNESS EXPERIMENTS - SOME RESULTS OF GROUND STUDIES

C. NOGUES and C. MILHAUD (Centre d'Etudes et de Recherches de Medecine Aerospatiale; Laboratoire Central de Biologie Aerospatiale, Paris, France) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 59, April 1988, p. 374-378. refs

A surgical method for iliac crest biopsy, designed for obtaining bone tissue from rhesus monkeys in future spaceborne experiments, was developed. The procedures of the biopsy and sample processing are described together with the results of ground

studies on the effect of simulated weightlessness on the bone remodeling parameters. The results demonstrate the decline of the osteoid matrix synthesis after immobilization. I.S.

**A88-33804**

## **NUCLEOTIDES OF THE BRAIN: METABOLISM AND EVALUATION UNDER OXYGEN DEFICIENCY [NUKLEOTIDY MOZGA: METABOLIZM I OTSENKA PRI KISLORODNOM GOLODANII]**

ELENA MIKHAILOVNA KHVATOVA, ALEKSANDRA NIKOLAEVN SIDORKINA, and GALI VLADIMIROVNA MIRONOVA Moscow, Izdatel'stvo Meditsina, 1987, 208 p. In Russian. refs

This book examines the role that purine nucleotides play in supplying the brain reactions with energy and in regulating the brain metabolism. Special consideration is given to the comparison of cerebral metabolism characteristics under normal conditions and with those under oxygen deficiency and to the specific roles of adenine and guanine nucleotides in specific metabolic reactions. It is shown that the progressive stages of brain ischemia lead to sequential decreases in the GTP, ATP, and creatinphosphate concentrations and that under growing oxygen deficiency the brain tissue is characterized by a concentration gradient of AMP which is steeper than the ATP gradient. I.S.

**A88-33833**

## **SYSTEMATICS AND ORIGIN OF ARCHEBACTERIA [SISTEMATICHESKOE POLOZHENIE I PROISKHOZHDENIE ARKHEBAKTERII]**

I. M. MIRABDULLAEV (AN USSR, Institut Zoologii i Parazitologii, Tashkent, Uzbek SSR) Akademiia Nauk SSSR, Izvestiia, Seria Biologicheskaiia (ISSN 0002-3329), Mar.-Apr. 1988, p. 175-185. In Russian. refs

The cellular characteristics of archebacteria were considered in the framework of their typology. It is shown that archebacteria possess typical procaryotic cytological structures and that its many molecular-level features are more similar to those in eubacteria than in eukaryotes. The same conclusion was reached after the analysis of 16-S RNA quenching data. The single feature which separates archebacteria from both eubacteria and eukaryotes is their unique lipids, in particular, the predominance in archebacteria of glycerol ethers, rather than the usual glycerol-fatty acid esters. A scheme of phylogenic relationship between the two procaryote groups (eubacteria and archebacteria) and four eukaryote kingdoms is presented. I.S.

**A88-33834**

## **MAGNETIC SPIN EFFECTS IN BIOLOGICAL SYSTEMS [MAGNITNYE SPINOVYE EFFEKTY V BIOLOGICHESKIKH SISTEMAKH]**

V. K. VANAG and A. N. KUZNETSOV (AN SSSR, Institut Khimicheskoi Fiziki, Moscow, USSR) Akademiia Nauk SSSR, Izvestiia, Seria Biologicheskaiia (ISSN 0002-3329), Mar.-Apr. 1988, p. 215-228. In Russian. refs

Biological reactions which could be affected by a magnetic field (MF) by the mechanism of spin exclusion are discussed. These are the radical reactions of lipid peroxidation, the enzyme reactions requiring the participation of a paramagnetic metal ion (e.g., reactions involving cytochrome P-450, catalase, and superoxidismutase), and the primary reactions in photosynthesis. In spite of the fact that, with the exception of some special regimes in the primary photosynthetic processes, there are presently no convincing data on the effect of MFs by the spin exclusion mechanism, the theoretical analysis of the various enzyme systems indicates a possibility of such an effect. The conditions for a magnetic-spin effect on biological reactions are discussed. I.S.

**A88-33836**

## **ACIDOPHILIC OCHROMONAS (CHRYSOPHYCEAE) FROM A SULFUR SPRING ON THE KUNASHIR ISLAND [ATSIDOFIL'NYI OCHROMONAS /CHRYSOPHYTA/ IZ SERNISTOGO ISTOCHNIKA NA OSTROVE KUNASHIR]**

B. V. GROMOV, K. A. MAMKAEVA, and V. D. BOBINA

(Leningradskii Gosudarstvennyi Universitet, Leningrad, USSR) Akademiia Nauk SSSR, Izvestiia, Seria Biologicheskaiia (ISSN 0002-3329), Mar.-Apr. 1988, p. 293-296. In Russian. refs

The characteristics of *Ochromonas vulcanus*, collected from a volcanic spring on the Kunashir island are presented. This organism optimally develops within a pH range of 1 to 6 and is very acid-resistant. The ambient temperature of the spring at the site of sampling was 42 C, but in the laboratory, the algae were grown at 20-25 C. The ultrastructural morphology of *Ochromonas* was found to be typical for Chrysophyceae, except for the appearance and the structure of the chloroplast. The lenslike chloroplast of *Ochromonas vulcanus* has a central pyrenoid surrounded by concentric rings of tylacoids. I.S.

**A88-33955**

## **SPACE PHYTOBIOLOGY - STATUS AND PROSPECTS [KOSMICHESKAIA FITO BIOLOGIIA - SOSTOIANIE I PERSPEKTIVY]**

K. M. SYTNIK and E. L. KORDIUM (AN USSR, Institut Botaniki, Kiev, Ukrainian SSR) Kosmicheskaiia Nauka i Tekhnika (ISSN 0321-4508), no. 1, 1986, p. 43-51. In Russian. refs

The paper surveys research on space phytobiology, i.e., the study of the growth and development of plants under the effect of space flight factors. Particular attention is given to the inclusion of plants in space life support systems in connection with the regeneration of oxygen and water. B.J.

**A88-34225#**

## **RELATION OF SPEED-VO<sub>2</sub> DURING TREADMILL RUNNING AND MEASUREMENT OF VO<sub>2</sub>MAX IN RATS**

MASAYUKI NAKAYA and SACHIO IKAWA (Jikei University, Tokyo, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), 24, Dec. 1987, p. 97-103. In Japanese, with abstract in English. refs

A respiratory mask was used to study oxygen consumption (VO<sub>2</sub>) of rats at four running speeds (40, 60, 80 and 100 cm/sec) and five grades (0, 5, 10, 15 and 20 percent at speed of 40 cm/sec). Expired air was collected from rats with respiratory mask every minute before and during exercise and analyzed by Scholander microgas analyzer. VO<sub>2</sub> values were calculated using the appropriate equations. VO<sub>2</sub> increased linearly as a function of running speed and treadmill grade. The maximal oxygen uptake (VO<sub>2</sub>max) of untrained male and female rats and trained female rats were determined in each rat. Repeated measurements indicated that the VO<sub>2</sub>max test was reliable, because the VO<sub>2</sub>max differences between the trial times were not apparent in untrained rats. And the continually trained rats had significantly higher VO<sub>2</sub>max values than untrained rats. The respiratory mask is useful for measurement of VO<sub>2</sub> during exercise and VO<sub>2</sub>max. Author

**A88-34558**

## **COLUMBUS AND THE LIFE SCIENCES**

MALCOLM B. WILKINS (ESA, Dept. of Botany, Glasgow, Scotland) (CNR and Aeritalia S.p.A., Columbus Symposium, 3rd, Capri, Italy, June 30-July 2, 1987) Space Technology - Industrial and Commercial Applications (ISSN 0277-4488), vol. 8, no. 1-2, 1988, p. 105-109.

Plans for life-science experiments in the ESA Columbus program are briefly reviewed. Topics addressed include the kinds of space medicine and human physiology experiments possible with the Spacelab Anthorack, Biorack gravitational biology experiments, integration of Anthorack and Biorack in the Attached Pressurized Module, the advantages (quiet and absence of microgravity fluctuations) and limitations (infrequent human intervention) of the Man-Tended Free Flyer for biological experiments, and the self-contained Botany facility to be carried by Eureca. Diagrams and drawings are provided. T.K.

**A88-34593\*** National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

## **A METHOD FOR RAPID LIQUID-SOLID PHASE SOLUBILITY MEASUREMENTS USING THE PROTEIN LYSOZYME**

MARC L. PUSEY (NASA, Marshall Space Flight Center, Huntsville,

AL) and KIM GERNERT (Duke University, Durham, NC) *Journal of Crystal Growth* (ISSN 0022-0248), vol. 88, no. 3, May 1, 1988, p. 419-424. Research supported by the Universities Space Research Association. refs

Using hen's egg white lysozyme crystals as the test material, a simple system was developed for rapidly and unambiguously determining solubilities in (aqueous) solutions. The system is based upon a maximization of the solid surface area available for solute transfer to or from the solution, and a minimization of both the solution volume which must be equilibrated and the distance over which diffusive solute exchange occurs. This technique is further enhanced by using duplicate test systems which differ only in that one approaches equilibrium from an oversaturated solution, while the other from an undersaturated solution. Thus, the resulting data pair brackets the solubility value. In practical terms, the data points are found to usually be within 3 percent of each other, and individual solubility data points may usually be made at this resolution within 8-24 h depending upon the temperature change made since the previous determination. Author

**A88-35136\*** Pennsylvania State Univ., University Park.

**LIFE SCIENCES, BIOTECHNOLOGY, AND MICROGRAVITY**

W. C. HYMER, C. HAYES (Pennsylvania State University, University Park), R. GRINDELAND (NASA, Ames Research Center, Moffett Field, CA), J. W. LANHAN (McDonnell Douglas Astronautics Co., Saint Louis, MO), and D. MORRISON (NASA, Johnson Space Center, Houston, TX) IN: *Aerospace century XXI: Space sciences, applications, and commercial developments; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986*. San Diego, CA, Univelt, Inc., 1987, p. 1333-1345. refs

(Contract NAS9-15565; NAS9-17416; NCC2-370; NASA ORDER A-21991-C)  
(AAS PAPER 86-464)

Growth hormone (GH) studies on rats flown aboard Spacelab 3 are discussed, and evidence for the direct effect of microgravity on cell function is reviewed. SL-3 rat GH cells were found to experience a secretory lesion (they contained more hormone per cell, but released less per cell relative to controls). Pituitary cell culture experiments on the STS-8 mission showed that GH cells did not subsequently release as much hormone as did control cells, indicating a secretory lesion. Changes in bone and muscle noted in SL-3 rats are related to GH cell findings. R.R.

**A88-36075**

**METHODS OF SYSTEM ANALYSIS IN SPACE BIOLOGY AND MEDICINE [SISTEMNYE METODY V KOSMICHESKOI BIOLOGII I MEDITSINE]**

VIACHESLAV VIACHESLA VERIGO Moscow, Izdatel'stvo Nauka (Problemy Kosmicheskoi Biologii. Volume 55), 1987, 216 p. In Russian. refs

The application of various methods of system analysis to problems in space biology and medicine is illustrated, and the relative value of different methods (e.g., statistical analysis, modeling, linear and nonlinear programming, and network methods) is assessed. Attention is given to the mathematical interpretation of homeostasis and to the various models of homeostasis, as well as to the modeling of the cardiorespiratory complex, water-salt exchange, and calcium homeostasis. Special consideration is given to modeling the effect of space flight on blood cells and their components, and on the immune system. The use of system analysis in the construction of biological life-support systems for future space flights and in the planning of planetary quarantine is illustrated. I.S.

**A88-36126**

**LOW-TEMPERATURE HEAT CAPACITY OF DNA IN VARIOUS CONFORMATIONAL STATES [NIZKOTEMPERATURNAYA TEPLOEMKOST' DNK, NAKHODIASHCHEISIA V RAZLICHNYKH KONFORMATSIONNYKH SOSTOYANIYAKH]**

E. L. ANDRONIKASHVILI, G. M. MREVLISHVILI, G. SH. DZHAPARIDZE, V. M. SAKHADZE, and D. A. TATISHVILI (AN

GSSR, Institut Fiziki, Tbilisi, Georgian SSR) *Biofizika* (ISSN 0006-3029), vol. 33, Mar.-Apr. 1988, p. 233-241. In Russian. refs

The temperature dependence (in the range of 4-400 K) of the heat capacity of native and denatured samples of salmon sperm Na-DNA which contained different amounts of water (between molar ratios of 0 and 23) was investigated. Three DNA states were examined: (1) native double-helix, (2) a disordered conformation, with polynucleotide chains in the state of statistical coils, and (3) a mechanical mixture of deoxyribonucleotides. The temperature-dependent entropy changes for these DNA products were found to depend on water content. I.S.

**N88-20805#** Pennsylvania Hospital, Philadelphia. Dept. of Molecular Biology.

**MOLECULAR AND ELECTRONIC MECHANISM IN THE CONTROL OF NA+ AND K+ PERMEABILITY OF EXCITABLE CELL MEMBRANE BY LIGAND BINDING ON RECEPTOR SITES** Annual Report, 1 Jul. 1986 - 31 Oct. 1987

GILBERT N. LING 12 Nov. 1987 7 p  
(Contract N00014-85-K-0573; PROJ. RR0-4108)

(AD-A188725) Avail: NTIS HC A02/MF A01 CSCI 06A

Our objective is to investigate the control of cell membrane permeability to Sodium (Na+), Potassium (K+), and other ions by transmitters, drugs, and other biologically potent ligands: to extend and test a general electronic theory of the control of physiological activities. GRA

**N88-20806#** California Univ., Berkeley. Lawrence Berkeley Lab.

**BIOPHYSICAL APPLICATIONS OF SOLID STATE AND TRITIUM NMR** Ph.D. Thesis

SUN UN Oct. 1987 193 p  
(Contract DE-AC03-76SF-00098)

(DE88-005328; LBL-24384) Avail: NTIS HC A09/MF A01

Novel applications of Magic Angle Sample Spinning (MASS) and Tritium (H-3) NMR to the study of mammalian tissue and in vivo metabolism, respectively, are described. The solid state P-31 MASS NMR spectra of sodium, magnesium, and calcium complexes of adenosine triphosphate (ATP) were recorded. These spectra indicate that the terminal phosphate group of the sodium complex is protonated in contrast to the unprotonated divalent complexes. The chemical shift tensors of a large variety of phosphates and phosphate esters were measured. The magnitude of the sigma sub 33, the low field, elements of the P-31 chemical shift tensors in these phosphates were linearly related to the longest P-O bonds and the sigma sub 11, the high field, elements to the shortest bonds. Similar relationships were found when these tensor elements were plotted against bond angles. The implications of these observations are discussed in the context of phosphorus-oxygen d-p pi bonding interactions. The P-31 and H-1 MASS NMR were applied to the study of lyophilized rat tissue. The 31P spectra exhibit resonances from phospholipids, DNA, ATP and NAD. The MASS results were compared to chemical analysis data obtained by others and to calculated spectra based on MASS data of model compounds. The H-1 MASS spectra of these tissue samples exhibited lines with widths less than 40 Hz, and were assigned to phospholipid protons. The intensity distribution of the H-1 spectra supported this assignment. Motionally narrowed P-31 and H-1 resonances suggest that the phospholipids undergo varying degrees of motion with correlation times ranging from 0.5 ns to 2 microsec. The degree of hydration of the DNA was also established. DOE

**N88-20807\*#** National Aeronautics and Space Administration, Washington, D.C.

**USE OF DIPHOSPHONATES TO CORRECT DISORDERS IN CALCIUM METABOLISM AND MINERAL COMPOSITION OF BONE TISSUE WITH 60-DAY HYPOKINESIA IN RATS**

B. V. MORUKOV, V. YE. ZAYCHIK, V. M. IVANOV, and O. I. ORLOV Mar. 1988 12 p Transl. into ENGLISH from *Patologicheskaya Fiziologiya i Eksperimental'naya Terapiya* (USSR), no. 2, 1987 p 75-77 Transl. by Scientific Translation



Service, Santa Barbara, Calif.

(Contract NASW-4307)

(NASA-TT-20220; NAS 1.77:20220) Avail: NTIS HC A03/MF A01 CSCL 06C

Compounds of the diphosphonate group suppress bone resorption and bone tissue metabolism, from which it was assumed that they can be used for the prevention of osteoporosis and disorders of calcium homeostasis in humans during space flight. Two compounds of this group were used for preventive purposes in 60 day hypokinesia in rats. The results showed that diphosphonates have a marked effect on calcium metabolism and the condition of the bone tissues under conditions of long term hypokinesia: they reduce the content of ionized calcium in blood, delay the loss of calcium and phosphorus by the bone tissue, and to a considerable degree prevent reduction of bone density. This confirms the possibility of using compounds of this group for correcting and preventing changes of bone tissue and mineral metabolism during long term hypokinesia. Author

**N88-21632#** California Univ., Berkeley. Lawrence Berkeley Lab.

**BIOLOGY AND MEDICINE DIVISION Annual Report, 1986**

Apr. 1987 292 p

(Contract DE-AC03-76SF-00098)

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The Biology and Medicine Division continues to make important contributions in scientific areas in which it has a long-established leadership role. For 50 years the Division has pioneered in the application of radioisotopes and charged particles to biology and medicine. There is a growing emphasis on cellular and molecular applications in the work of all the Division's research groups. The powerful tools of genetic engineering, the use of recombinant products, the analytical application of DNA probes, and the use of restriction fragment length polymorphic DNA are described and proposed for increasing use in the future. DOE

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## AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**A88-32801**

**OPERATION EVEREST. II - OXYGEN TRANSPORT DURING EXERCISE AT EXTREME SIMULATED ALTITUDE**

JOHN R. SUTTON, JOHN T. REEVES, PETER D. WAGNER, BERTRON M. GROVES, ALLEN CYMERMAN (McMaster University, Hamilton, Canada; Colorado, University, Denver; California, University, La Jolla; U.S. Army, Research Institute of Environmental Medicine, Natick, MA; Vermont, University, Burlington) et al. Journal of Applied Physiology (ISSN 0161-7567), vol. 64, April 1988, p. 1309-1321. Research supported by the Arctic Institute of North America. refs

(Contract DAMD17-85-C-5206; NIH-HL-14985; NIH-HL-17731)

In this study, the effect of altitude on the O<sub>2</sub> transport parameters was investigated by measuring cardiovascular and blood gas indices in healthy male subjects at rest, and during steady-state exercise at sea level and in the course of a 40-day simulated ascent of Mt. Everest. As the inspired oxygen pressure decreased from 80 torr at sea level to 43 torr at the end of the experiment, maximal O<sub>2</sub> uptake decreased from 3.98 l/min to 1.17 l/min. This was associated with profound hypoxemia and hypocapnia. However, at maximal effort, the O<sub>2</sub> uptake of greater than 1 l/min was achieved despite severe hypoxemia, indicating that humans are able to work at ambient O<sub>2</sub> pressure said to be at the limits of survival. Among the factors responsible for the transfer of O<sub>2</sub> to the tissues, the most important adaptations were found to occur in ventilation parameters, where a fourfold increase

in alveolar ventilation was observed. Diffusion from the alveolus to end-capillary blood was unchanged with altitude, as was the mass circulatory transport of O<sub>2</sub> to the tissue capillaries. I.S.

**A88-32803**

**VENTILATORY RESPONSE TO SUSTAINED HYPOXIA AFTER PRETREATMENT WITH AMINOPHYLLINE**

P. A. EASTON and N. R. ANTHONISEN (Manitoba, University, Winnipeg, Canada) Journal of Applied Physiology (ISSN 0161-7567), vol. 64, April 1988, p. 1445-1450. Research supported by the Medical Research Council of Canada. refs

The possible role of adenosine in the hypoxia-induced ventilatory decline in humans was investigated by employing aminophylline as an adenosine blocker. Eight young adults were pretreated with either intravenous saline or aminophylline before being exposed to 25 min of sustained isocapnic hypoxia. Compared with 24.8 percent decrease in peak hypoxic ventilation after 25 min of hypoxia, ventilation in aminophylline-treated subjects was found to decrease only by 12.8. The ventilatory decline in aminophylline-treated subjects was achieved predominantly through alterations in respiratory timing (unlike the usual tidal volume-dependent attenuation of hypoxic ventilation exhibited by saline-injected controls). I.S.

**A88-32804**

**CARBON DIOXIDE EFFECTS ON THE VENTILATORY RESPONSE TO SUSTAINED HYPOXIA**

P. A. EASTON and N. R. ANTHONISEN (Manitoba, University, Winnipeg, Canada) Journal of Applied Physiology (ISSN 0161-7567), vol. 64, April 1988, p. 1451-1456. Research supported by the Medical Research Council of Canada. refs

The effect of supplemental carbon dioxide on the ventilatory response to sustained moderate (80-percent arterial saturation) hypoxia was investigated in human subjects under two conditions. In one experiment, sustained hypoxia was evaluated after the introduction of hypercapnia; in another, the effect of isocapnic hypoxia was compared with that of poikilocapnic hypoxia. Under conditions of continuous hypercapnia, introduction of hypoxia caused a brisk additional increase in inspiratory minute ventilation to 284 percent of resting value, followed by a decline to a level intermediate between the initial increase and the preexisting hypercapnic hyperventilation. These trends in ventilation, i.e., an initial peak followed with a decline, were also found when the results of isocapnic and poikilocapnic conditions were compared, suggesting that the mechanism underlying the hypoxic decline is not CO<sub>2</sub>-dependent. I.S.

**A88-32805**

**LINEAR RELATIONSHIP BETWEEN VO<sub>2</sub>(MAX) AND VO<sub>2</sub>(MAX) DECREMENT DURING EXPOSURE TO ACUTE HYPOXIA**

JOHN LAWLER, SCOTT K. POWERS, and DIXIE THOMPSON (Louisiana State University, Baton Rouge) Journal of Applied Physiology (ISSN 0161-7567), vol. 64, April 1988, p. 1486-1492. refs

Changes in the maximal O<sub>2</sub> uptake, VO<sub>2</sub>(max), were measured in trained endurance-athletes (T) and untrained individuals (UT) performing bicycle ergometer tests under two conditions: (1) normoxic and (2) hypoxic (14 percent O<sub>2</sub>/86 percent N<sub>2</sub>). During maximal exercise under hypoxia, the T group was found to exhibit significantly lower degree of oxyhemoglobin saturation and larger normoxic/hypoxic decrements in VO<sub>2</sub>(max) than did the UT subjects. Moreover, the VO<sub>2</sub>(max) decrements were found to correlate linearly with the relative values of normoxic VO<sub>2</sub>(max). The data demonstrate that highly trained athletes, with their high normoxic values of VO<sub>2</sub>(max), experience greater gas-exchange impairments during acute exposure to hypoxia than do UT individuals. I.S.

**A88-32806**

**EXERCISE THERMOREGULATION AFTER PROLONGED WAKEFULNESS**

MARGARET A. KOLKA and LOU A. STEPHENSON (U.S. Army,

Research Institute of Environmental Medicine, Natick, MA) *Journal of Applied Physiology* (ISSN 0161-7567), vol. 64, April 1988, p. 1575-1579. refs

#### A88-32807

**EFFECT OF SIMULATED ALTITUDE ERYTHROCYTHEMIA IN WOMEN ON HEMOGLOBIN FLOW RATE DURING EXERCISE**  
ROBERT J. ROBERTSON, RONALD GILCHER, KENNETH F. METZ, CARL J. CASPERSEN, THOMAS G. ALLISON (Pittsburgh, University, PA) et al. *Journal of Applied Physiology* (ISSN 0161-7567), vol. 64, April 1988, p. 1644-1649. refs

**A88-33547\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

#### THE ENDOCRINE SYSTEM IN SPACE FLIGHT

C. S. LEACH, P. C. JOHNSON, and N. M. CINTRON (NASA, Johnson Space Center, Houston, TX) (IAF, International Astronautical Congress, 37th, Innsbruck, Austria, Oct. 4-11, 1986) *Acta Astronautica* (ISSN 0094-5765), vol. 17, Feb. 1988, p. 161-166. refs  
(IAF PAPER 86-382)

A trial natriuretic factor (ANF), a hormone recently shown to regulate sodium and water excretion, has been measured in blood specimens obtained during flight. After 30 or 42 h of weightlessness, mean ANF was elevated. After 175 or 180 h, ANF has increased by 59 percent, and it changed little between that time and soon after landing. There is probably an increase in ANF early inflight associated with the fluid shift, followed by a compensatory decrease in blood volume. Increased renal blood flow may cause the later ANF decrease. Erythropoietin (Ep), a hormone involved in the control of red blood cell production, was measured in blood samples taken during the first Spacelab mission and was significantly decreased on the second day of flight, suggesting also an increase in renal blood flow. Spacelab-2 investigators report that the active vitamin D metabolite 1 alpha, 25-dihydroxyvitamin D-3 increased early in the flight, indicating that a stimulus for increased bone resorption occurs by 30 h after launch. Author

**A88-33548\*** National Aeronautics and Space Administration, Washington, D.C.

#### RADIATION DOSE AND SHIELDING FOR THE SPACE STATION

PERCIVAL D. MCCORMACK (NASA, Office of Space Station, Washington, DC) (IAF, International Astronautical Congress, 37th, Innsbruck, Austria, Oct. 4-11, 1986) *Acta Astronautica* (ISSN 0094-5765), vol. 17, Feb. 1988, p. 231-241. refs  
(IAF PAPER 86-380)

Significant differences in dose prediction for Space Station arise depending on whether or not the magnetic field model is extrapolated into the future. The basis for these calculations is examined in detail, and the importance of the residual atmospheric layer at altitudes below 1000 km, with respect to radiation attenuation, is emphasized. Dosimetry results from Shuttle flights are presented and compared with the computed results. It is recommended that, at this stage, no extrapolation of the magnetic field into the future be included in the calculations. A model adjustment, to replace this arbitrary procedure, is presented. Dose predictions indicate that, at altitudes below 500 km and at low inclination, and with nominal module wall thickness (0.125 in. aluminum), orbit stay times of 90 days in Space Station would result in quarterly radiation doses to the crew, which are well within present limits for both males and females. Countermeasures would be required for stay times of a year or more and the measure of increasing shielding is examined. Author

#### A88-33576

#### HORMONAL STATUS AND FLUID ELECTROLYTE METABOLISM IN MOTION SICKNESS

A. I. GRIGORIEV, I. A. NICHIPORUK, V. V. YASNETSOV, and V. S. SHASHKOV (Institut Mediko-Biologicheskikh Problem, Moscow, USSR) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 59, April 1988, p. 301-305. refs

Variations of hormonal status and fluid electrolyte balance during a vestibular stimulation test were examined in healthy humans in two series of experiments, each studying groups of individuals who were either highly, moderately, and not susceptible to motion sickness. In one experiment, the subjects received no drugs; in another, subjects were pretreated with either scopolamine, pimozide, or a synthetic analog of vasopressin. In the untreated group, all high-susceptibility subjects displayed increases of blood ACTH, STH, ADH, cortisol, and aldosterone and of plasma renin activity. The moderate-susceptibility subjects exhibited still higher increases of all hormones, except plasma renin, while the low-susceptibility subjects displayed considerable increases only in ACTH, cortisol, and STH. Among the pretreated subjects, immediate increases of STH, cortisol, ADH, aldosterone, and renin were observed in the moderate-susceptibility but not in the high-susceptibility subject (who displayed hormonal increases one hour later), indicating presence in this later group of some specific immediate adaptation mechanism. I.S.

**A88-33577\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

#### EFFECT OF ANTIORTHOSTATIC BED REST ON HEPATIC BLOOD FLOW IN MAN

L. PUTCHA, N. M. CINTRON, J. M. VANDERPLOEG, Y. CHEN, J. HABIS (NASA, Johnson Space Center; Kelsey Seybold Clinic, Houston, TX) et al. *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 59, April 1988, p. 306-308. refs

Physiological changes that occur during exposure to weightlessness may induce alterations in blood flow to the liver. Estimation of hepatic blood flow (HBF) using ground-based weightlessness simulation models may provide insight into functional changes of the liver in crewmembers during flight. In the present study, HBF, indirectly estimated by indocyanine green (ICG) clearance, is compared in 10 subjects during the normal ambulatory condition and antiorthostatic (-6 deg) bed rest. Plasma clearance of ICG was determined following intravenous administration of a 0.5-mg/kg dose of ICG to each subject on two separate occasions: once after being seated for 1 h, and once after 24 h of head-down bed rest. After 24 h of head-down bed rest, hepatic blood flow did not change significantly from the respective control value. Author

#### A88-33578

#### OBSERVATIONS ON PILOT NEUROSENSORY CONTROL PERFORMANCE DURING SACCADIC EYE MOVEMENTS

JOHN D. ENDERLE (North Dakota State University, Fargo) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 59, April 1988, p. 309-313. refs  
(Contract F33615-83-D-0603)

Saccadic eye movement system performance was investigated to determine whether neurosensory and motor system function is improved by training. There were two populations studied: 12 Air National Guard pilots, individuals with extensive visual training, and 12 nonpilots. Each subject executed 54 saccadic eye movements while tracking an LED target which moved at random from one location to another. The target display consisted of nine small LEDs, each separated by 5 deg. The ordering of the target movements, as well as the time interval between target movements, were randomized. Horizontal saccadic eye movements were recorded from infrared signals reflected from the anterior surface of the cornea. Signals for bilateral tracking were digitized using an analog-to-digital converter and stored in the hard disk of an IBM/XT. Results using advanced digital processing techniques indicate no significant differences in neurosensory and motor system function during saccadic eye movements between the two populations. A time-optimal central nervous system control mechanism is described which cannot be improved upon by training or exercise. Author

**A88-33580\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**VERTICAL DISPLACEMENT THRESHOLD SENSITIVITY ALONG THE HORIZONTAL MERIDIAN AS A FUNCTION OF STIMULUS RATE, DURATION, AND LENGTH**

RICHARD F. HAINES and STEVEN M. KIEFEL (NASA, Ames Research Center, Moffett Field; De Anza College, Cupertino, CA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 321-329. refs

Four independent variables of visual perception during binocular viewing were studied. In 24 observers, the vertical displacement threshold (DT) sensitivity along the horizontal meridian was determined as a function of the rate, duration, and length of the stimulus. It was found that the DT increases with an increased angular separation of the stimulus image from the fovea (i.e., the stimulus must move farther in order to be correctly discriminated as having moved). In addition, it was found that the sensitivity to the stimulus displacement increases with increasing of the stimulus length, duration, and/or angular rate. These findings are related to the design optimization of dynamic attitude displays and symbology for aircraft. I.S.

**A88-33581**

**CARDIOVASCULAR RESPONSE TO LOWER BODY NEGATIVE PRESSURE (LBNP) FOLLOWING ENDURANCE TRAINING**

NEIL B. VROMAN, JOHN A. HEALY, and ROBERT KERTZER (New Hampshire, University, Durham) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 330-334. refs

The effect of an aerobic conditioning program (12 weeks of endurance exercise) on the cardiovascular response to lower body negative pressure (LBNP) was studied by comparing the responses of previously sedentary individuals (E group) who have undergone the exercise program to those of the controls (C group) who did not participate in the program. After training, the maximal oxygen uptake was found to increase significantly in the E but not in C subjects. Both C and E subjects showed similar decreases in systolic blood pressure (BP), and similar increases in heart rate and diastolic BP during LBNP. The forearm blood flow (FBF) decreased significantly due to the -40 mm Hg of LBNP in C subjects and in the E subjects during pretraining period. After 12 weeks of conditioning, the E subjects exhibited a significantly attenuated decrease in the FBF fall due to -40 mm Hg LBNP, indicating that the endurance training caused a decrease in the forearm vasoconstrictor response to high levels of LBNP. I.S.

**A88-33582**

**EXERCISE RESPONSES AFTER SHORT- AND LONG-TERM RESIDENCE AT 2,200 METERS**

CARL M. MARESH, WILLIAM J. KRAEMER, BRUCE J. NOBLE, and KENNETH L. ROBERTSON (Wyoming, University, Laramie; Connecticut, University, Storrs) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 335-339. Research supported by the University of Wyoming. refs

Submaximal and maximal exercise responses were examined in persons residing at a moderate altitude for different periods of time. Long-term residents (LTRs: 44 males, 11 females) had lived continuously between 1830 and 2200 m for 2 years or longer before testing. Short-term residents (STRs: 22 males, 30 females), previously lowlanders, arrived at 2200 m within 10 to 21 days before testing. Incremented tests on a motor-driven treadmill were performed until voluntary exhaustion. Cardiorespiratory measures and ratings of perceived exertion (RPE) were examined at 60 percent and 100 percent of maximal oxygen uptake,  $V(O_2\max)$ . With the exception of minute ventilation, which was higher ( $p$  less than 0.05) in STR females, maximal responses were comparable in STR and LTR females. All maximal responses were similar in STR and LTR males. Both  $V(E)$  and RPE at 60 percent  $V(O_2\max)$  were significantly higher in STR males and females than in their LTR counterparts. Plasma lipid responses to the maximal exercise may indicate a greater contribution of the triglyceride pool of

adipose tissue to fatty acid mobilization during exercise in the LTR compared to STR male subjects. Author

**A88-33583**

**THE EFFECTS OF EXCESS BODY FAT ON FINE MOTOR PERFORMANCE FOLLOWING PHYSICAL EXERTION**

MAURICE JETTE, ROBERT KERR, JEAN-LUC LEBLANC, and WILLIAM LEWIS (Ottawa, University; DND, Directorate of Preventive Medicine, Canada) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 340-344. refs (Contract DND-3204-536)

The combined effects of excess body fat and physical exertion on the ability of an individual to perform a fine motor task were investigated in individuals classified as belonging to three groups according to the percentage of body fat: (1) A, no more than 14.9 (the desirable percentage), (2) B, 15 to 24.9 percent, and (3) C, no less than 25 percent. Motor performance was assessed with a tracometer, before and after heavy treadmill exercise. For all groups, moderate exercise had no effect on tracometer performance, while heavy exercise led to an immediate deterioration in performance followed by a slight improvement. Excess body fat was not found to significantly affect the postexercise fine motor performance. I.S.

**A88-33584**

**HEAT EXCHANGE DURING ENCAPSULATION IN A CHEMICAL WARFARE AGENT PROTECTIVE PATIENT WRAP IN FOUR HOT ENVIRONMENTS**

LOU A. STEPHENSON, MARGARET A. KOLKA, ANNE E. ALLAN, and WILLIAM R. SANTEE (U.S. Army, Research Institute of Environmental Medicine, Natick, MA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 345-351. Army-supported research. refs

**A88-33586**

**NECK INJURY SUSTAINED DURING EXPOSURE TO HIGH-G FORCES IN THE F16B**

HARALD T. ANDERSEN (Institute of Aviation Medicine, Oslo, Norway) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 356-358.

Neck pain is a frequent complaint among aviators flying high performance fighter (HPF) aircraft. However, very few, if any, cases of subjective symptoms have been confirmed by objective methods and reported in the literature. The present paper relates an incident of documented injury of the cervical spine which occurred during an abrupt and violent maneuver in the F16B. The rear seat occupant, a flight surgeon, who had just handed over controls to the instructor flying from the front seat, was caught unaware. He suffered a ligament injury C(5-6) and a sliding of the C(6) relative to the C(5). It is concluded that the accelerative forces in HPF aircraft can cause serious injury to the cervical spine and its supporting structures in the neck and, thus, aircrew not engaged in the flying task may be at risk if left ignorant of pilots' intentions. Lightweight helmets reduce the medical hazards imposed upon aviators in the high-G environment. Specific exercises aimed at strengthening the neck muscles are encouraged. Author

**A88-33587**

**USAF TAKE-OFF AND LANDING EJECTIONS, 1973-85**

GEOFFREY W. MCCARTHY (USAF, Hospital Misawa, Japan) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 359-362. refs

This paper presents a review of ground-level ejection data from 1973 through 1985 for cases of ejections occurring during take-off and landing that clearly involved a decision between ground egress and ejection. Survival rate and the rate of major injuries were compared (by the chi-square analysis) to all ejections above 500 ft and to other ejections below 500 ft during the same period. There were 15 aircraft with 25 crewmembers, 22 of whom ejected. It was found that survival and injury rates for ground-level ejection did not differ significantly from those above 500 ft, indicating that ejection during take-off and landing phases is as safe as ejection above 500 ft, and safer than other ejections below 500 ft. Compared



to ground egress, ejection offered greatly increased chances for survival (in only 33 percent of cases the ground egress would have been possible). I.S.

#### A88-33802

##### **HUMAN PHYSIOLOGY UNDER HIGH ALTITUDE CONDITIONS [FIZIOLOGIA CHELOVEKA V USLOVIAKH VYSOKOGOR'IA]**

O. G. GAZENKO, ED. Moscow, Izdatel'stvo Nauka, 1987, 520 p. In Russian. No individual items are abstracted in this volume.

Data are presented on the characteristic changes in physiological parameters that were measured in the participants of major high-altitude stations and, in particular, mountain expeditions. Special chapters are devoted to the following biomedical aspects of the 1982 Soviet Mt. Everest expedition: the procedure of candidate selection; medical control and the treatment-and-prophylactic medical service during the preparatory and the ascent stages of the expedition; the sanitary and hygiene provisions; the aspects of high-altitude metabolism; and the management of adequate nutrition, water, and oxygen requirements of the expedition members at high altitudes. The construction and the efficiency of various oxygen masks are compared, with special attention given to the equipment designed for the participants of the 1982 expedition. I.S.

#### A88-33835

##### **A SHIFT IN THE SET POINT OF TEMPERATURE REGULATION UNDER PHYSICAL LOAD CONDITIONS [SDVIG USTANOVOCHNOI TOCHKI TEMPERATURNOI REGULIATSII V USLOVIAKH FIZICHESKOI NAGRUZKI]**

A. S. PAVLOV (Voroshilovgradskii Mashinostroitel'nyi Institut, Voroshilovgrad, Ukrainian SSR) Akademiia Nauk SSSR, Izvestiia, Seriia Biologicheskai (ISSN 0002-3329), Mar.-Apr. 1988, p. 229-237. In Russian. refs

Human organisms exposed to prolonged physical load with the accompanying muscle hyperthermia experience a shift in the temperature set point rather than a tendency to return to the original temperature. This paper examines the changes in the temperature-regulation set point under physical load and the role of the set-point shift in the increase in the work capacity observed after reaching the stable level of core hyperthermia. It is shown that the new set point which is about 1.5 C above the normothermic level is accompanied by the optimal mobilization of the cardiorespiratory system. The new set point is stable, i.e., it is physiologically regulated. I.S.

#### A88-34156#

##### **IN-FLIGHT RECOVERY FROM G-INDUCED LOSS OF CONSCIOUSNESS: THE OTHER SIDE OF THE PROBLEM**

WILLIAM B. ALBERY, TRACY A. GORDON, JAMES R. COOPER, and ALVA A. KARL (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 996-999. refs

Prompted by a realization of how little is known about appropriate countermeasures to restore pilot consciousness and functional effectiveness once g-induced loss of consciousness (GLOC) has occurred, attention is given to what measures may be taken in-flight to facilitate pilot recovery in single-seat aircraft. GLOC countermeasures to be evaluated encompass immediate negative-g acceleration, which increases mean eye-level blood pressure and restores cerebral perfusion; immediate g-suit inflation, which has a similar effect; and the application of noxious olfactory or auditory stimuli. O.C.

#### A88-35434

##### **POSTURAL DISEQUILIBRIUM FOLLOWING TRAINING FLIGHTS**

J. E. FOWLKES, R. S. KENNEDY (Essex Corp., Orlando, FL), and M. G. LILIENTHAL (U.S. Navy, Naval Training Systems Center, Orlando, FL) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa

Monica, CA, Human Factors Society, 1987, p. 488-491. Research supported by Martin Marietta Energy Systems, Inc. refs (Contract N61339-81-C-0105; N61339-85-D-0026)

The paper reports on postural disequilibrium following training in eight Navy flight simulators. Tests of standing steadiness were administered to 726 Naval and Marine Corps aviators before and just after their regular flight training. Statistically significant ataxic effects were found after simulator exposure. The implications of these findings for safety are considered. B.J.

#### A88-35437\*

National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

##### **SIMULATOR SICKNESS RESEARCH PROGRAM AT NASA-AMES RESEARCH CENTER**

MICHAEL E. MCCAULEY (Monterey Technologies, Inc., Carmel CA) and ANTHONY M. COOK (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 502-504. refs

The simulator sickness syndrome is receiving increased attention in the simulation community. NASA-Ames Research Center has initiated a program to facilitate the exchange of information on this topic among the tri-services and other interested government organizations. The program objectives are to identify priority research issues, promote efficient research strategies, serve as a repository of information, and disseminate information to simulator users. Author

#### A88-35438

##### **SIMULATOR INDUCED SYNDROME - EVIDENCE FOR LONG TERM SIMULATOR AFTEREFFECTS**

TIMOTHY J. UNGS (USCG, Washington, DC; Wright State University, Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 505-509. refs

The purpose of this study was to determine the incidence, risk factors, and significance of adverse symptoms occurring in pilots more than 24 hours after completion of flight simulator training. This continued occurrence or recurrence of symptoms is termed as 'Long Term Simulator Aftereffects' (LTSA). Information was gathered by multi-part, anonymous, and voluntary questionnaire. Nine of 196 pilots studied reported LTSA. Several pilots reported symptoms up to one week and one three weeks after simulator training. Symptoms reported included: recurrent visual flashbacks, continued disturbance in balance, difficulties in concentrating and hand-eye discoordination. Three pilots reported difficulties in flying aircraft. Author

#### A88-35686

##### **LOSS OF CONSCIOUSNESS UNDER ACCELERATION LOADS [PERTES DE CONNAISSANCE SOUS FACTEUR DE CHARGE]**

J. M. CLERE (USAF, School of Aerospace Medicine, Brooks AFB, TX), H. MAROTTE, G. FLORENCE, and H. VIEILLEFOND (Centre d'Essais en Vol, Bretigny-sur-Orge, France) (Societe Francaise de Medecine Aerospatiale, Meeting, Paris, France, Nov. 21, 1986) Medecine Aeronautique et Spatiale, vol. 26, 3rd Quarter, 1987, p. 197-201. In French. refs

Heart rate (HR) and systolic blood pressure (SBP) measurements were obtained in order to investigate loss of consciousness (LC) due to high-g acceleration in combat aircraft. For nine LC cases, the mean acceleration level was  $7.22 \pm 0.139$  g, with the event usually occurring near the beginning of the acceleration plateau. The average duration of LC was  $14.63 \pm 0.166$  sec. The events were also characterized by clonic movements, amnesia, and increases in HR and SBP. The present results can be explained by Von Diringshofen's hemodynamic theory and by the incorrect execution of respiratory protection maneuvers. R.R.

A88-35689

**STUDY OF THE COURSE OF MYOPIC REFRACTION IN YOUNG SUBJECTS - ITS IMPACT ON THE SELECTION OF AIR FORCE PILOTS [ETUDE DU DEVENIR DES REFRACTIONS MYOPIQUES DU SUJET JEUNE - SON INCIDENCE SUR LA SELECTION DES PILOTES DE L'ARMEE DE L'AIR]**

M. MAILLE, P. J. MANENT, P. CREPY, CH. CORBE (Centre Principal d'Expertise Medicale du Personnel Navigant, Paris, France), and J. L. BATISSE (Centre d'Essais en Vol, Bretigny-sur-Orge, France) (Societe Francaise de Medecine Aeronautique, Meeting, Paris, France, Nov. 21, 1986) *Medecine Aeronautique et Spatiale*, vol. 26, 3rd Quarter, 1987, p. 210-216. In French.

Myopic refraction is evaluated as a cause for unfitness in the selection of air force personnel. The condition was found to occur in about 10 percent of French air force candidates between 1981 and 1985, and it has been found to become more severe with age in 13.4 percent of the subjects. Changes in visual acuity up to the age of 27 have been evaluated for candidates diagnosed with the condition at ages of between 18 and 24. The study reveals three different categories of varying fitness potential. It is noted that myopic refraction may appear up to the age of 25.

R.R.

A88-35690

**ARTERIAL HYPERTENSION AND VASCULAR RISK FACTORS - PROBLEMS WITH RESPECT TO AERONAUTICAL FITNESS [HYPERTENSION ARTERIELLE ET FACTEURS DE RISQUE VASCULAIRE - PROBLEMES EN MATIERE D'APTITUDE AERONAUTIQUE]**

A. SEIGNEURIC (Hopital d'Instruction des Armees Dominique Larrey, Versailles, France) *Medecine Aeronautique et Spatiale*, vol. 26, 3rd Quarter, 1987, p. 221-228. In French. refs

The occurrence of arterial hypertension (AH) among aeronautical personnel is investigated, and the establishment of fitness guidelines with respect to AH is discussed. A progressive increase is found in the number of aeronautical personnel hospitalized due to hypertension between 1976 and 1985. The risk of hypertension is found to be less for the aeronautical population than for the general population, and it only becomes significant around the age of 45. The occurrence of mild hypertension in middle-aged pilots is considered in detail.

R.R.

A88-35691

**TM ECHOCARDIOGRAPHY AND HYPERTENSION IN YOUNG ADULTS [ECHOCARDIOGRAPHIE TM ET HYPERTENSION DE L'ADULTE JEUNE]**

H. ILLE, A. DIDIER, N. ALLEGRI, and J. L. MONIEZ (Centre Principal d'Expertise Medicale du Personnel Navigant, Paris, France) *Medecine Aeronautique et Spatiale*, vol. 26, 3rd Quarter, 1987, p. 239-245. In French. refs

The echocardiographic evaluation of various types of clinical arterial hypertension (CAH) in subjects of less than 40 years of age is discussed. Among the various echocardiographic parameters, the left ventricular mass is found to be a good hypertensive indicator and a good means of evaluating the potential efficacy of antihypertensive treatment. Changes in right ventricular diastolic function occur only in severe CAH. Although the left auricle diameter is significantly enlarged in hypertensive young adults, its potential role as a hypertensive indicator requires further investigation.

R.R.

A88-35692

**ARTERIAL HYPERTENSION THERAPY IN FLIGHT PERSONNEL [THERAPEUTIQUE DE L'HYPERTENSION ARTERIELLE DANS LE PERSONNEL NAVIGANT]**

J. P. BURLATON, J. P. GOURBAT, and A. SEIGNEURIC (Hopital d'Instruction des Armees Dominique Larrey, Versailles, France) *Medecine Aeronautique et Spatiale*, vol. 26, 3rd Quarter, 1987, p. 246-250. In French. refs

Uncomplicated, moderate arterial hypertension (MAH) and its consequences for the fitness of flight personnel are discussed. It

is noted that the goal of hypertensive therapy is to minimize vascular risk, not to normalize blood pressure in order to maintain aeronautical fitness standards. Among the possible courses of treatment, many, such as vasodilators and angiotensin converting enzyme inhibitors, are not suitable for flight personnel due to their harmful side-effects. Guidelines are given for the administration of authorized medications such as beta blockers and diuretics. It is suggested that moderate MAH under correct medical supervision may be compatible with aeronautical fitness.

R.R.

A88-35700

**AERONAUTICAL MEDICAL TREATMENT - CARDIOVASCULAR CAUSES OF LACK OF FITNESS FOR AIRCRAFT PILOTS [MISES AU POINT EN MEDICINE AERONAUTIQUE - LES CAUSES CARDIO-VASCULAIRES D'INAPTITUDE AU PILOTAGE DES AVIONS]**

A. DIDIER, J. P. GOURBAT, J. L. MONIEZ, D. BATOU, C. CHARBOT (Centre Principal d'Expertise Medicale du Personnel Navigant, Paris; Hopital d'Instruction des Armees Dominique Larrey, Versailles, France) et al. *Medecine Aeronautique et Spatiale*, vol. 26, 4th Quarter, 1987, p. 344-350. In French. refs

Data on flight personnel found to be unfit are examined in order to study flight fitness and difficulties in the evaluation of the risk due to cardiovascular conditions. Of the 457 personnel reviewed, 55.6 percent were declared unfit due to cardiovascular problems. Problems in establishing fitness guidelines for arterial hypertension include the setting of 'normal' blood pressure limits and the possible side-effects of hypertensive treatments. Other conditions considered include arteriosclerosis, EKG anomalies, ventricular arrhythmia, and valve trouble.

R.R.

A88-36009

**SPATIAL ORGANIZATION OF THE ELEMENTS REVEALED IN THE DETECTION OR IDENTIFICATION OF VISUAL STIMULI [PROSTRANSTVENNAIA ORGANIZATSIIA ELEMENTOV, VYIYAVLIAEMYKH V USLOVIAKH OBNARUZHENIIA ILI OPOZNANIYA ZRITEL'NYKH STIMULOV]**

V. M. BONDARKO and V. E. GAUZEL'MAN (AN SSSR, Institut Fiziologii, Leningrad, USSR) *Fiziologiya Cheloveka* (ISSN 0131-1646), vol. 14, Mar.-Apr. 1988, p. 204-211. In Russian. refs

The spatial organization of visual-system elements participating in the detection and identification of visual stimuli was studied. Subjects were asked to signal the detection thresholds and to identify stimuli that consisted of a series of vertical stripes or a rectangular lattice. The contrast thresholds were determined using the 'scaling' method. The analysis of weight functions calculated for spatial elements involved in the detection and in the identification processes has revealed significant differences in the organization of these elements. The results of these analyses are interpreted in terms of different mechanisms responsible for the detection and the identification processes.

I.S.

A88-36010

**EFFECT OF TRANSLATITUDINAL RELOCATIONS ON SOME CHARACTERISTICS OF HEAT EXCHANGE IN HUMANS [VLIYANIE TRANSSHROTNYKH PEREMESHCHENII NA NEKOTORYE POKAZATELI TEPLOOBMENA U CHELOVEKA]**

G. M. DIVERT and S. G. KRIVOSHCHIEKOV (AMN SSSR, Institut Fiziologii, Novosibirsk, USSR) *Fiziologiya Cheloveka* (ISSN 0131-1646), vol. 14, Mar.-Apr. 1988, p. 231-236. In Russian. refs

The effect of a translational relocation on the heat exchange system of humans was investigated in six subjects flown from Novosibirsk to Frunze (where the average temperature was about 10-15 C higher) and, two weeks later, back to Novosibirsk. Parameters characterizing the status of the heat exchange system were measured before flight, 2 days and 2 weeks after arrival, and 2 days after return, when subjects were at rest and doing physical work at two temperatures of the constant-temperature chamber: 26 and 13 C. It was found that, upon relocation, subjects exhibited both nonspecific thermoregulating responses (i.e., responses not depending upon the sign of climatic contrast), which

manifest themselves at 26 C, and specific responses, which are manifested at 13 C. As a nonspecific response, subjects exhibited an increase of mean surface temperature, a decrease in sensitivity to cold, and a decrease of temperature gradient between the core and surface temperature. Among specific responses measured at 13 C were the changes in the mean skin temperature (an increase in hot climate and a decrease in cold) and changes in the core-surface temperature gradients. I.S.

**A88-36011**

**CARBOHYDRATE AND LIPID METABOLISM AND ITS HORMONAL REGULATION DURING REPEATED PERIODS OF STRENUOUS WORK OF THRESHOLD INTENSITY [UGLEVODNIY I LIPIDNIY OBMEN I EGO GORMONAL'NAIA REGULIATSIIA PRI POVTORNOM VYPOLNENII PREDEL'NOI RABOTY VYSOKOI INTENSIVNOSTI]**

V. V. MEN'SHIKOV, IA. M. KOTS, O. L. VINOGRADOVA, L. V. KOSTINA, E. V. OZOLINA (Gosudarstvennyi Tsentral'nyi Institut Fizicheskoi Kul'tury; Vsesoiuznyi Nauchno-Issledovatel'skii Institut Fizicheskoi Kul'tury; I Moskovskii Meditsinskii Institut, Moscow, USSR) et al. Fiziologiya Cheloveka (ISSN 0131-1646), vol. 14, Mar.-Apr. 1988, p. 256-262. In Russian. refs

**A88-36012**

**INCREASE OF THE CIRCULATING BLOOD VOLUME AS A FACTOR OF ELEVATED AEROBIC ENDURANCE [UVELICHENIE OB'EMA TSIRKULIRUIUSHCHEI KROVI KAK FAKTOR POVYSHENIIA AEROBNOI VYNOSLIVOSTI]**

V. I. FILIMONOV (Zaporozhskii Gosudarstvennyi Meditsinskii Institut, Zaporozhe, Ukrainian SSR) Fiziologiya Cheloveka (ISSN 0131-1646), vol. 14, Mar.-Apr. 1988, p. 272-280. In Russian. refs

The parameters of central and regional hemodynamics that characterize the activity of the oxygen-transport system were correlated with the level of the circulating-blood volume (CBV) in athletes specializing in activities that demand high physical endurance (sprinters, long-distance runners, and pole vaulters). It was found that, depending on the CBV of the subject, many cardiovascular parameters differed in value and direction. The most effective adaptive changes indicating the elevated oxygen capacity of blood (e.g., high stroke volume, high CBV of the lung, and low peripheral-vessel resistance) were found in the group of runners with relatively high (above 80 ml/kg) CVB. I.S.

**A88-36013**

**MODERN CONCEPTS CONCERNING THE PSYCHOPHYSIOLOGICAL SIGNIFICANCE OF P(300) [SOVREMENNYE PREDSTAVLENIYA O PSIKHOFIZIOLOGICHESKOI ZNACHIMOSTI R/300/]**

I. E. KANUNIKOV and V. I. VETOSHEVA (Leningradskii Gosudarstvennyi Universitet, Leningrad, USSR) Fiziologiya Cheloveka (ISSN 0131-1646), vol. 14, Mar.-Apr. 1988, p. 314-323. In Russian. refs

This paper discusses the significance of one of the components of the evoked-potential (EP) record, the so-called P(3), P(300), or late positive oscillation. This factor has been shown to correlate with the variety of characteristics of mental activity in humans, such as decision making, the level of attention, the orientation reaction, and the learning process. The analysis of studies directed towards finding a common mental activity factor responsible for these correlations has shown that the P(300) component is inhomogeneous, but consists of two or more oscillations, whose genesis is related to different regions of the brain. Various theories regarding the origin of the P(300) component are discussed. I.S.

**A88-36025**

**BIOMECHANICS OF THE SPINE UNDER ACCELERATION IMPACT LOADING IN AIR AND SPACE FLIGHTS [BIMEKHANIKA POZVONOCHNIKA PRI UDARNYKH PEREGRUZKAKH V PRAKTIKE AVIATSIONNYKH I KOSMICHESKIKH POLETOV]**

GURII PETROVICH STUPAKOV, ARKADII PAVLOVICH

KOZLOVSKII, and VALERII SEMENOVICH KAZEIKIN Leningrad, Izdatel'stvo Nauka (Problemy Kosmicheskoi Biologii. Volume 56), 1987, 240 p. In Russian. refs

The responses of the human spine to acceleration impact loading and the limits of tolerance to such impacts are discussed, with emphasis placed on the effects of such loading on the vertebral column in air and space flights. Attention is given to the morphological characteristics of the human spine; the biomechanical features of the vertebra and the intervertebral disks; the resistance characteristics of the spine under conditions of acceleration impact loading; the load parameters; the role of environmental factors in the tolerance to an impact in the cranio-pelvic direction; and to the biomechanical aspects of clinical investigation, diagnosis, and outcome of spinal injuries. Special consideration is given to the construction of a man-ejection seat model and to its application to the studies of ejection-induced impact overloads. Finally, the problems of weightlessness-induced osteodystrophy are considered together with the mechanical devices designed to ameliorate the effect of weightlessness. I.S.

**A88-36100**

**METHODS AND CRITERIA FOR ESTIMATING OVERFATIGUE IN FLIGHT PERSONNEL [METODY I KRITERII OTSENKI PEREUTOMLENNIA LETNOGO SOSTAVA]**

V. A. BODROV, A. N. KOL'TSOV, and V. A. SERGEEV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), Feb. 1988, p. 61-64. In Russian.

The qualitative and quantitative measures of chronic fatigue, overfatigue, and overfatigue complicated by neurosis are assessed. Physiological, psychological, and biochemical analyses were conducted on subjects in whom overfatigue symptoms of differing severity were induced by physical exercise. The results showed that the most sensitive indices signaling acute fatigue were the skin electroconductivity, coordination, light-flicker fusion, reaction time to visual stimuli, heart rate, and orthostatic and step tests. Methods related to voluntary activity, such as counting at a prescribed rate or a search for prescribed numbers, were not informative. I.S.

**N88-20808#** Naval Health Research Center, San Diego, Calif.

**LIFTING AND CARRYING CAPACITIES RELATIVE TO PHYSICAL FITNESS MEASURES Final Report**

MARCIE B. BECKETT and JAMES A. HODGDON 21 Oct. 1987 49 p (AD-A189305; NHRC-87-26) Avail: NTIS HC A03/MF A01 CSCL 05I

Through the Physical Readiness Test (PRT), the Navy assesses the physical fitness and body composition of its members. Those fitness attributes which contribute to optimal Navy job performance have not yet been fully identified. The purpose of this study was to determine the extent to which performance of simulated general shipboard work can be predicted by measures of physical capacity. Three tasks representative of general shipboard work were developed - a long duration carry and two maximal box lifting tests. These tasks, as well as, PRT items (including lean body mass LBM from body circumference and weight), other field fitness measures, and Incremental Lift Machine (ILM) tests were performed by 102 Navy men and women. Substitution of broad jump score for LBM offers a small improvement in task prediction. ILM scores offer lift capacity prediction comparable to that obtained from PRT and broad jump scores. LBM, broad jump and ILM scores are all strong indicators of overall body strength. If these prediction methods are to be implemented as screening or selection tools, critical lifting and carrying task parameters for Navy jobs must be defined. In addition, further research is needed to cross-validate results obtained in this study and to expand prediction application. GRA

**N88-20809#** Letterman Army Inst. of Research, San Francisco, Calif.

**PURSUIT TRACKING PERFORMANCE DECREMENTS ASSOCIATED WITH DECREASING AMBIENT ILLUMINATION Final Report, Feb. - Jul. 1987**



JEROME W. MOLCHANY, DAVID A. STAMPER, and DAVID J. LUND Aug. 1987 30 p  
(AD-A189336; LAIR-243) Avail: NTIS HC A03/MF A01 CSCL 17E

Reduction in ambient illumination alters one's ability to acquire and track moving targets. In this study we have attempted to describe the relationship between decreasing ambient illumination and pursuit tracking performance. Eight male volunteers used an optical tracking device to track targets at a constant angular velocity of 5 mrad/sec under bright and reduced ambient light levels in the BLASER tracking simulator. Reduction of the ambient light level was accomplished by inserting neutral density filters into the optics of the tracking device. Volunteers were assigned randomly to a schedule of 6 levels of reduced ambient illumination. Analysis of Variance for the Percent Time-on-Target (Percent TOT), horizontal Root Mean Square (RMS) error, and Maximum Absolute Error (MAE) revealed highly significant main effects. Ambient light levels below 0.075 cd/sq.m. produced large tracking error scores (e.g., Percent TOT less than 68 percent). The use of direct view optics below luminance levels of 0.18 cd/sq.m. could seriously jeopardize the success of the mission. GRA

**N88-20810#** Army Research Inst. of Environmental Medicine, Natick, Mass.

**PLASMA CORTISOL, RENIN AND ALDOSTERONE DURING AN INTENSE HEAT ACCLIMATION PROGRAM**

LAWRENCE E. ARMSTRONG, RALPH P. FRANCESCONI, WILLIAM J. KRAEMER, NATALIE LEVA, and JANE P. DELUCA Sep. 1987 20 p  
(AD-A189387) Avail: NTIS HC A03/MF A01 CSCL 06J

The effects of an intense, intermittent heat acclimation (HA) regimen on stress and fluid balance hormones responses were examined in 13 unacclimated male volunteers. Venous blood samples were collected before (PRE) and after (POST) exercise and analyzed for plasma renin activity (PRA), aldosterone (ALD), cortisol (PC), plasma volume shifts (delta PV percent), sodium (Na+) and potassium (K+). Subjects exhibited physiological adaptations typical of HA decreased heart rate, rectal temperature, skin temperature, and improved defense of PV. While plasma Na+ demonstrated no change during daily exercise, K+, PC, PRA, and ALD increased more than delta PV percent accounted for. PRA and ALD did not change as a result of HA, but PRE vs POST PC responses were attenuated. The dissociation of PRA and ALD levels on day 4 of HA (POST) may be explained by differences in splanchnic clearance mechanisms. It was concluded that during an intense HA regimen, electrolyte and hormonal responses to exercise in the heat are modulated by the acquisition of acclimation. GRA

**N88-20811#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**RETINOTOPIC MAPPING OF THE HUMAN VISUAL SYSTEM WITH MAGNETOENCEPHALOGRAPHY M.S. Thesis**

MICHAEL G. DOWLER Dec. 1987 72 p  
(AD-A189557; AFIT/GEP/ENP/87D-6) Avail: NTIS HC A04/MF A01 CSCL 06D

A retinotopic mapping was verified using magnetoencephalography as the means to observe brain activity in one human subject. The stimulus consisted of 12 sectors of a hemicycle, 6 foveal and 6 peripheral out to about 17 degrees visual field angle. The sectors flashed individually for 63 milliseconds with an inter-stimulus-interval between .8 and 1.8 seconds. The recording computer was synchronized to the stimulus and recorded for .5 seconds after onset of stimulus. Thirty averages were taken for each stimulus section, for each of about 45 grid points on the scalp. The sectors were localized to distinct points in the primary visual cortex (area 17). The results did not verify the cruciform model of retinotopic mapping nor the theory that more visually eccentric stimuli produce deeper responses. The data seem to suggest and different type of mapping for foveal stimuli than peripheral, but this could also be due to the fold structure of the primary visual cortex. GRA

**N88-20812#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**AN ANALYSIS OF PHYSIOLOGICAL DATA RELATED TO MOTION SICKNESS FOR USE IN A REAL-TIME MOTION SICKNESS INDICATOR M.S. Thesis**

MICHAEL E. DRYLIE Dec. 1987 86 p  
(AD-A189589; AFIT/GE/ENG/87D-16) Avail: NTIS HC A05/MF A01 CSCL 06E

The goal of this thesis project was to continue to collect physiological data on volunteers as motion sickness was induced, analyze the data collected, test and improve motion sickness indicators previously developed, for use in a real-time processor, and develop a method for testing the susceptibility to motion sickness for individuals. The existing data acquisition system was modified to produce better accuracy of the measured data. Additional sensors were added, sensor types and placements were modified. Circuits were modified to prevent overloading and to allow better tracking of the full range of expected physiological data points. Previous indicators were evaluated as to their accuracy and degree of their usefulness in a real-time processor. A susceptibility test was developed to allow the classification of a person as to their level of motion sickness susceptibility. Physiological data were analyzed on the basis of their relationship with the onset of motion sickness, to develop a motion sickness indicator. GRA

**N88-20813\*#** National Aeronautics and Space Administration, Washington, D.C.

**CHANGES IN THE STATUS OF THE HUMAN TIBIA DURING ANTIORTHOSTATIC HYPOKINESIA**

A. M. TATARINOV, A. I. GRIGORYEV, V. V. DZENIS, KH. A. YANSON, V. S. OGANOV, and A. S. RAKHMANOV Mar. 1988 20 p Transl. into ENGLISH from Mekhanika Kompozitnykh Materialov (Riga, USSR, Zimatne), 1986 p 134-143 Transl. by Scientific Translation Service, Santa Barbara, Calif.  
(Contract NASW-4307)

(NASA-TT-20221; NAS 1.77:20221) Avail: NTIS HC A03/MF A01 CSCL 06P

Changes were studied in biomechanical properties of the human tibia during prolonged antiorthostatic hypokinesia with different modes of motor activity and pharmacotherapy and comparison of results obtained with parallel examinations using ultrasonic diagnosis and photon absorptiometry. Author

**N88-20814\*** National Aeronautics and Space Administration, Washington, D.C.

**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 309)**

Apr. 1988 57 p  
(NASA-SP-7011(309); NAS 1.21:7011(309)) Avail: NTIS HC A04 CSCL 06E

This bibliography lists 136 reports, articles and other documents introduced into the NASA scientific and technical information system in February, 1988. Author

**N88-20815** Joint Publications Research Service, Arlington, Va.  
**JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: LIFE SCIENCES Abstracts Only**

15 Mar. 1988 36 p Transl. into ENGLISH from various Russian articles  
(JPRS-ULS-88-004) Avail: Issuing Activity

Translations of scientific and technological articles from Russian journals, books, and other publications are presented. The subject heading is Life Sciences. Subheadings include: Biochemistry, Biophysics, Biotechnology, Epidemiology, Human Factors, Immunology, Laser Bioeffects, Medicine, Microbiology, Molecular Biology, Pharmacology and Toxicology, Physiology, and Public Health.

**N88-20816** Joint Publications Research Service, Arlington, Va.  
**INCREASE IN INFLUENCE OF OXYGEN ON THE BODY IN THE PRESENCE OF HELIUM Abstract Only**

M. M. SEREDENKO and YE. V. ROZOVA In its JPRS Report:

Science and Technology. USSR: Life Sciences p 26 15 Mar. 1988 Transl. into ENGLISH from Fiziologiya Cheloveka (Moscow, USSR), v. 13, no. 3, May - Jun. 1987 p 463-468  
 Avail: Issuing Activity

An attempt is made to estimate the combined influence of oxygen and helium on the body over a broad range of oxygen concentrations in the gas mixture breathed, using 105 healthy volunteers and 78 subjects with chronic pulmonary insufficiency. The subjects breathed mixtures containing 40, 21, 14.5 and 11 percent oxygen in nitrogen or helium. Subjects with pulmonary insufficiency were given mixtures containing 40 and 21 percent oxygen only. Exposure time was 20 minutes. Helium increased the hyperoxic effect, decreasing the level of gas metabolism. Systems supporting the body with oxygen concentrations when mixed with helium, and hyperoxia is increased at higher oxygen concentrations. Author

**N88-20817** Joint Publications Research Service, Arlington, Va.  
**REGULATION OF HEMODYNAMICS UPON IMITATION OF THE TRANSITION TO WEIGHTLESSNESS (MATHEMATICAL MODELING) Abstract Only**

B. L. PALETS, A. A. POPOV, M. A. TIKHONOV, and V. S. PANCHENKO In its JPRS Report: Science and Technology. USSR: Life Sciences p 26 15 Mar. 1988 Transl. into ENGLISH from Fiziologiya Cheloveka (Moscow, USSR), v. 13, no. 4, Jul. - Aug. 1987 p 627-632 Original language document was announced in IAA as A88-14728

Avail: Issuing Activity

A mathematical model of human circulation dynamics, based on the model of Palets et al., was used to study rapid responses of the cardiovascular system to the onset of weightlessness. The model was also used to study the effects on circulation of some weightlessness counteracting methods, such as hypovolemia, lower body negative pressure (LBNP), and hip cuffs. The analytical results show that upon the onset of weightlessness, the right heart ventricle, due to the blood volume overload, starts to function in a plateau range of the accretion function. Hypovolemia, LBNP, and occlusion cuffs all function to decrease the volume load of the right ventricle. Among the counter weightlessness methods, the LBNP is the most effective. E.R.

**N88-20818\*#** National Aeronautics and Space Administration, Washington, D.C.

**THE EFFECTS OF NORMAL AND THERAPEUTIC BATHS ON THE CENTRAL VASCULAR ORGANS OF PERSONS WITH HEALTHY HEARTS, AS MEASURED BY X-RAY**

G. BOEHM and FR. EKERT Apr. 1988 21 p Transl. into ENGLISH from Deutsches Archiv F. Klin. Med. (Fed. Republic of Germany), v. 182, 1938 p 598-610 Transl. by Scientific Translation Service, Santa Barbara, Calif.

(Contract NASW-4307)

(NASA-TT-20252; NAS 1.77:20252) Avail: NTIS HC A03/MF A01 CSCI 06P

According to current information, baths have a four-fold effect on the circulation: (1) Dilation or constriction is produced in the area of the blood vessels in the skin as a result of thermal, chemical or mechanical stimuli; (2) This reaction in the dermal vascular system produces a further effect on the central vessels in the extremities, the area of the splanchnicus, and other body cavities; (3) The reflect transposition of other organ systems, i.e., the respiratory organs, has a reaction on the circulation; and (4) The water pressure of the bath has a hydrostatic effect, i.e., on the one hand it empties peripheral veins more rapidly, and on the other it increases the intra-abdominal pressure and this reduces once again the circulation in the area of the splanchnicus.

Author

**N88-21633#** Southampton Univ. (England). Inst. of Sound and Vibration Research.

**FURTHER INVESTIGATION OF TESTS FOR SUSCEPTIBILITY TO NOISE-INDUCED HEARING LOSS**

B. W. LAWTON and D. W. ROBINSON Jul. 1987 52 p

(Contract MOD-2040/0366(APRE))

(ISVR-TR-149; ETN-88-91904) Avail: NTIS HC A04/MF A01

Thirty men highly resistant to noise, were subjected to hearing tests as in Lawton and Robinson (1986). Results suggest that susceptibility to noise-induced hearing loss is likely to be associated with poor temporal integration and with abnormal tone-on-tone masking discrimination; possibly also with weak acoustic reflex action. By carrying out the three tests required to determine the above measures at the pre-exposure stage, in addition to the usual tests of hearing sensitivity by pure-tone audiometry, it would be possible to earmark systematically a proportion of those tested as being the most likely to be noise-susceptible. This process is probabilistic rather than deterministic and the number so earmarked is a matter of judgement: there is no sharp cut off on any of the measures that divides a population unambiguously into susceptible and not susceptible. Short forms of the tests, suitable for initial screening, could be developed. ESA

**N88-21634#** Southampton Univ. (England). Inst. of Sound and Vibration Research.

**VISUALIZATION OF THE AIR FLOWING THROUGH A DYNAMIC MODEL OF THE VOCAL FOLDS**

CHRISTINE H. SHADLE, STEPHEN J. ELLIOT, and PHILIP A. NELSON Oct. 1987 34 p Sponsored by NATO and a Hunt Fellowship

(ISVR-TR-154; ETN-88-91905) Avail: NTIS HC A03/MF A01

Aerodynamic effects of vocal fold vibration were investigated with a life-size dynamic model of the vocal folds and surrounding vocal tract. Pressure-flow measurements were made for 4 fixed positions of the model (glottal areas of 6, 12, 18, 24 mm sq) to enable comparison of the model to other static studies. These show that although the entrance to the model glottis was unrealistically abrupt, the model nevertheless exhibits realistic pressure-flow characteristics. Flow downstream of the glottis was visualized while one fold vibrated against the other with a forced sinusoidal excitation. Photographs were taken at 45 deg intervals throughout the cycle for 2 flowrates (200, 350 cc/sec) 2 fundamental frequencies (80, 100 Hz), and 2 supraglottal acoustic impedances. The photos show development of a jet within each glottal cycle, demonstrating an insufficiency of static models in which phase angle is not a parameter. Lengthening the supraglottal tract so that FO approximately equaled the tract's quarter-wavelength resonance tends to make the jet form earlier in the cycle, and cannot be adequately explained. ESA

**N88-21635#** Royal Air Force Inst. of Aviation Medicine, Farnborough (England).

**VALIDATION OF MATHEMATICAL MODEL PREDICTIONS OF IMMERSION SURVIVAL TIMES**

P. J. SOWOOD, J. R. ALLAN, and J. B. COHEN May 1987 26 p (IAM-652; BR102901; ETN-88-92052) Avail: NTIS HC A03/MF A01

The survival times of aircrew immersed in cold water wearing standard aircrew equipment assemblies were estimated using a mathematical model of human thermoregulation. The accuracy of the model was validated by comparing its predictions of metabolic rates, surface heat loss, skin temperatures, and core temperatures with those measured during a series of cold water immersions using subjects wearing a range of protective clothing. The results indicate that the model predicts overall change in core temperature with sufficient accuracy to allow it to be used to predict realistic and safe estimates of survival time. ESA

## BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**A88-32861\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

# **DISTORTIONS OF PERCEIVED VISUAL DIRECTIONS OUT OF PICTURES**

STEPHEN R. ELLIS (NASA, Ames Research Center, Moffett Field, CA; California, University, Berkeley), STEPHEN SMITH (California State University, San Jose), and MICHAEL W. MCGREEVY (NASA, Ames Research Center, Moffett Field, CA) Perception and Psychophysics (ISSN 0031-5117), vol. 42, no. 6, 1987, p. 535-544. refs

Two experiments are reported examining judgments from 16 subjects who indicated the apparent direction of a photographed pointer that was rotated to different physical positions while being photographed. The photographs themselves were rotated about a vertical axis to several positions with respect to the subjects' central viewing axis. The results replicate the well-known distortion in apparent direction associated with photographed pointers positioned to project directly out of the plane of the photograph. This effect has been described by Goldstein (1979) as the 'differential rotation effect' because its magnitude is reduced as the depicted angle of the pointer becomes less orthogonal to the photograph. Analysis of the two-dimensional properties of the projected images shows that this differential rotation is related to projected angles on the surface of the photograph. This analysis may explain why circular objects often do not appear to be correctly drawn in the periphery of geometrically correct projections.

Author

**A88-33753**

# **VISUAL COMPUTATION AND SACCADIC EYE MOVEMENTS - A THEORETICAL PERSPECTIVE**

JOHN M. FINDLAY (Durham, University, England) Spatial Vision (ISSN 0169-1015), vol. 2, no. 3, 1987, p. 175-189. refs

A simple instance of parallel computation in neural networks occurs when the eye orients to a novel visual target. Consideration of target-elicited saccadic eye movements opens the question of how spatial position is represented in the visual pathways involved in this response. It is argued that a point-for-point retinotopic coding of spatial position (the 'local sign' approach) is inadequate to account for the characteristics of the response. An alternative approach based on distributed coding is developed.

Author

**A88-33769\*** Texas Univ., Austin.

# **EXPLORING FLIGHTCREW BEHAVIOUR**

ROBERT L. HELMREICH (Texas, University, Austin) Social Behaviour (ISSN 0885-6249), vol. 2, 1987, p. 63-72. refs (Contract NCC2-286)

A program of research into the determinants of flightcrew performance in commercial and military aviation is described, along with limitations and advantages associated with the conduct of research in such settings. Preliminary results indicate significant relationships among personality factors, attitudes regarding flight operations, and crew performance. The potential theoretical and applied utility of the research and directions for further research are discussed.

Author

**A88-34154**

# **WORKLOAD DURING LINGUISTIC PROCESSING**

RONALD M. KATSUYAMA (Dayton, University, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 979-986. refs

A secondary tone discrimination task was used to assess the cognitive capacity required while reading script-related and

script-unrelated sentences. Passages were presented in either regular order (condition 1,  $n = 29$ ) or random order (condition 2,  $n = 26$ ). Tests of comprehension and memory for details were administered immediately following reading and, again, one week later. In contrast to the decline in recognition of details and identification of false statements, the identification of implied statements improved across test sessions. Finally, implied statements were recognized as rapidly as were original script sentences on which they were based. These results are discussed in terms of script theory. I.E.

**A88-34215**

# **EFFECT OF NOISE ON A DUAL TASK: SUBJECTIVE AND OBJECTIVE WORKLOAD CORRELATES**

WILLIAM B. ALBERY, DANIEL W. REPPERGER, GARY B. REID (USAF, Harry G. Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH), CHARLES GOODYEAR, LIGIA E. RAMIREZ (Systems Research Laboratories, Inc., Dayton, OH) et al. IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1457-1463.

The effect of noise on the subjective and objective measures of mental workload is presented, as well as the effect of primary and dual-task performance on reaction time. The effect of noise served as the biodynamic stressor. Pink noise consisted of two levels, 90 and 100 dBA. Physiological parameters monitored included EKG, EEG, arm muscle EMG, eye blink, and blood pressure. It was found that 90- and 100-dB noise had little effect on subject performance. The subjective workload of subjects increased approximately 50 percent from ambient to 90 dB and 33 percent from 90 to 100 dB. I.E.

**A88-35406**

# **ALTERNATIVE APPROACHES TO ANALYZING SWAT DATA**

DAVID W. BIRS (Dayton, University, OH) and PHILIP J. MASLINE (Systems Research Laboratories, Inc., Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 63-66. refs

The present study sought to determine the sensitivity of three alternative approaches to deriving a workload composite measure based upon data gathered using the Subjective Workload Assessment Technique (SWAT) and to determine through the use of multivariate statistical procedures (MANOVA) if anything is to be gained by retaining the individual scale information of SWAT. The three rating scale dimensions of SWAT (time load, mental effort load, psychological stress load) were combined into a single workload composite using three techniques: conjoint measurement; a simple sum of the three scales weighted equally; an empirically determined weighted-linear combination of the three scales (from MANOVA). Using data gathered by having subjects perform a continuous memory task under twelve levels of task difficulty, it was found that the three composite measures were equally sensitive and highly correlated (the minimum correlation among the three composites being 0.9913). The results of the MANOVA performed on the same data indicated that the individual scales of SWAT were differentially sensitive to different task demands and that individual scale information should be retained rather than rely on a simple composite. Author

**A88-35407**

# **SUBJECTIVE WORKLOAD UNDER INDIVIDUAL AND TEAM PERFORMANCE CONDITIONS**

BARRY H. BEITH (North Carolina State University, Raleigh) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 67-71. refs

This study compares an individual's workload when working alone versus working with another person on a complex cognitive task. Twenty-four participants worked alone and in dyadic teams under varying conditions of team interaction and time stress. Measures of performance and individual ratings of self and team

workload were recorded. Results address subjective workload under individual and team conditions. Further individual perceptions of personal workload and team workload are compared. These results have implications for the use of teams in operational systems. Author

**A88-35408\*** Purdue Univ., West Lafayette, Ind.  
**DECISION SUPPORT FOR WORKLOAD ASSESSMENT - INTRODUCING WC FIELDE**

PATRICIA A. CASPER (Purdue University, West Lafayette, IN), ROBERT J. SHIVELY, and SANDRA G. HART (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 72-76. refs

Currently there is a great demand for mental workload evaluation in the course of system design and modification. In light of this demand, a microprocessor-based decision support system has been created called WC FIELDE: Workload Consultant for FIELD Evaluation. The system helps the user select workload measures appropriate to his or her application from the large pool of currently available techniques. Both novices and those with some workload experience may benefit from using WC FIELDE, since the system's operation is entirely transparent and all rules involved in the decision process are available for the user to examine. WC FIELDE recommends several assessment methodologies in decreasing order of appropriateness, and provides additional information on each measure at the end of the program in the form of text files. Author

**A88-35409**  
**AN EXAMINATION OF PROJECTIVE VERSUS POST-TASK SUBJECTIVE WORKLOAD RATINGS FOR THREE PSYCHOMETRIC SCALING TECHNIQUES**

PHILIP J. MASLINE (Systems Research Laboratories, Inc., Dayton, OH) and DAVID W. BIRS (Dayton, University, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 77-80. refs

**A88-35410**  
**STIMULUS PROBABILITY, SURPRISE, AND REACTION TIME**

TARALD O. KVALSETH (Minnesota, University, Minneapolis) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 147-150. refs

This paper is concerned with the relationship between human reaction time for individual stimuli and their surprise values. A new measure of surprise is introduced that incorporates the probability of an individual stimulus occurring as well as the probabilities of the remaining potential stimuli. Experimental data are used to test the proposition that the reaction time for a stimulus is an increasing function of the surprise value of that stimulus. This proposition does indeed appear to be acceptable. Author

**A88-35411**  
**THE IMPACT OF AUTOMATION ON ERROR DETECTION - SOME RESULTS FROM A VISUAL DISCRIMINATION TASK**

ROBERT B. FULD, YILI LIU, and CHRISTOPHER D. WICKENS (Illinois, University, Champaign) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 156-160. refs

A dynamic decision-making task was designed for microcomputer that allowed subjects to operate in either a manual mode, or an automatic mode. Nine subjects performed in a repeated measures design that presented identical errors for detection in the two modes. Results showed that sensitivity was higher in the automatic model the manual mode elicited a conservative response bias. NASA bipolar rating scales presented a clear picture of higher workload in the manual mode. Author

**A88-35412**  
**SIMULATOR DESIGN FEATURES FOR HELICOPTER SHIPBOARD LANDINGS**

DANIEL J. SHEPPARD, SHERRIE A. JONES (Essex Corp., Orlando, FL), and JOYCE MADDEN (U.S. Navy, Naval Training Systems Center, Orlando, FL) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 233-237. (Contract CT\*\*N61339-85-D-0026)

The Vertical Takeoff and Landing Simulator (VTOL) at the Naval Training Systems Center's (NTSC) Visual Technology Research Simulator (VTRS) was used to study the effects of simulator design features on pilot performance in helicopter shipboard landings. The research was designed to evaluate the effects of current design features on the SH-60B Operational Flight Trainer (OFT) used to train helicopter shipboard landing and four proposed simulator design modifications. These were: (1) scene detail (SH-60B OFT scene versus an upgraded VTRS scene), (2) field-of-view (VTRS wide versus a smaller SH-60B OFT field-of-view), (3) dynamic seat cueing (on versus off), and (4) dynamic inflow (standard rotor model available in existing trainers versus an updated rotor model). These factors were tested across two levels of seastate. On the basis of the factors studied in the experiment, the wider field-of-view, the more detailed scene and the updated rotor model are recommended for use. The dynamic seat cueing evaluated in his study is not recommended at this time. Author

**A88-35414\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**STEP TRACKING SHRINKING TARGETS**

WALTER W. JOHNSON and SANDRA G. HART (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 248-252.

Four models describing how people might acquire targets that dynamically vary in size were examined; two that described movement speed as a simple function of target size (either initial or final) and two that described movement speed as a function of the predicted size of the targets at a fixed time in the future (one was referenced to the beginning of the reaction time phase, and the other to the end of this phase). It was found that movement time was best described as a function of a size prediction made at the end, rather than the start, of the reaction time phase. Subjective workload ratings primarily reflected the total amount of time needed to acquire the targets rather than the time pressure imposed by the diminishing size of these targets. Author

**A88-35415\*** Illinois Univ., Urbana-Champaign.  
**TIME-SHARING VISUAL AND AUDITORY TRACKING TASKS**

PAMELA S. TSANG (Illinois, University, Urbana) and MICHAEL A. VIDULICH (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 253-257. refs

An experiment is described which examined the benefits of distributing the input demands of two tracking tasks as a function of task integrality. Visual and auditory compensatory tracking tasks were utilized. Results indicate that presenting the two tracking signals in two input modalities did not improve time-sharing efficiency. This was attributed to the difficulty insensitivity phenomenon. B.J.

**A88-35417**  
**INDUCED ROLL VECTION FROM STIMULATION OF THE CENTRAL VISUAL FIELD**

GEORGE J. ANDERSEN and BRIAN P. DYRE (Illinois, University, Urbana) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 263-265. refs (Contract NSF BNS-86-07217)

The perception of induced roll vection (rotation about the line

of sight) from visual stimulation of the central visual field (CVS) was investigated. Subjects viewed computer generated displays that simulated observer motion relative to a volume of randomly positioned points. It was found that induced roll vection occurred with stimulation restricted to a 10-deg diameter area of the CVS, and that greater postural instability occurred for display with a 30-deg roll as compared with a 15-deg roll. Significantly greater postural instability occurred along the X-axis (left/right) as compared with the Y-axis (front/back). The implications of this research for flight simulation are discussed. B.J.

A88-35422

**THE EFFECT OF CONSTRUCTING MULTIPLE-CHOICE  
DISTRACTOR ITEMS AROUND A SINGLE TARGET  
ALTERNATIVE**

MICHAEL S. WOGALTER and BRADLEY D. MARWITZ (Richmond, University, VA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 378-381. refs

Experiments were conducted to determine whether the construction of multiple-choice test alternatives based around a critical target answer would facilitate the selection of the target answer. Results suggest that test-makers should avoid constructing distractor alternatives around a correct alternative because the information provided in the set of alternatives may influence test-takers to select the target answer without any knowledge of the information being assessed. B.J.

A88-35423

**THE DEVELOPMENT OF A SPATIAL ORIENTATION TASK  
FOR INCLUSION IN THE CRITERION TASK SET (CTS)**

DONALD J. POLZELLA (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH), PHILIP J. MASLINE, JOHN R. AMELL, WILLIAM A. PEREZ, ERIC G. RAMSEY (Systems Research Laboratories, Inc., Dayton, OH) et al. IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 394-397.

Twelve subjects performed the airplane task, a test of spatial ability, in order to determine whether or not the task is suitable for inclusion in the CTS battery. Subjects performed 12 trials of the task on four consecutive days. Both performance and subjective measures were recorded. Three significantly different loading levels were obtained using the rear, front, and bottom views of the plane. It was concluded that the airplane task appears to be suitable for inclusion in the CTS. Author

A88-35424

**A MULTIDIMENSIONAL SCALING ANALYSIS OF SUBJECTIVE  
WORKLOAD ASSESSMENT TECHNIQUE (SWAT) RATINGS OF  
THE CRITERION TASK SET (CTS)**

DONALD J. POLZELLA and GARY B. REID (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 398-401. refs

A nonmetric weighted multidimensional scaling (MDS) procedure was used to analyze Subjective Workload Assessment Technique (SWAT) ratings of the Criterion Task Set (CTS). The results indicated that over 94 percent of the variability in SWAT ratings of CTS tasks could be represented in two orthogonal dimensions: response time and task effort. Author

A88-35425

**RELATIONSHIP BETWEEN CRITERION TASK SET  
PERFORMANCE AND THE PERSONALITY VARIABLES OF  
SENSATION SEEKING AND STIMULUS SCREENING**

KIRBY GILLILAND, ROBERT SCHLEGEL, and SHARON DANNELS (Oklahoma, University, Norman) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987,

Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 402-404. refs  
(Contract F33615-85-D-0514)

The purpose of this study was to demonstrate the utility of the Criterion Task Set (CTS) as a method for personality theory testing. Subjects in a large CTS Standardization study were administered the Sensation Seeking scale and the Stimulus Screening scale, two personality dimensions based theoretically on perceptual or biological processes that are believed to mediate task performance. Results indicated that high sensation seekers respond faster, but not necessarily more accurately, than low sensation seekers to central processing tasks. No differences were found for input/perceptual or motor/output tasks. Also, no differences were found between screeners and nonscreeners for any CTS tasks. The results of this study suggest that the CTS can be used profitably by personality researchers to test the basic assumptions of the theories of some personality dimensions. Author

A88-35426

**THE CRITERION TASK SET - AN UPDATED BATTERY**

JOHN R. AMELL (Systems Research Laboratory, Inc., Dayton, OH), F. THOMAS EGGEMEIER (Dayton, University; USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH), and WILLIAM H. ACTON (New Mexico, University, Albuquerque) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 405-409. refs

The Criterion Task Set (CTS) is a battery of human performance tasks designed to place demands on a range of operator information processing functions required in complex tasks. Several tasks in the CTS have been modified as a result of validation studies carried out on the original battery. New loading levels for these tasks have been established. In addition to task changes, several modifications have been made in the user interface. Added features include: a 30-sec trial option, automatic trial number incrementing, a file naming convention, and a data reduction program. B.J.

A88-35427

**HUMAN FACTORS CONSIDERATIONS FOR ENHANCING  
PERFORMANCE IN THE NAVAL AIRSHIP**

LAUREN B. LEVETON, BETHANY H. DRUM, PETER ENGEL, and TIMOTHY K. O'DONOHUE (Science Applications International Corp., McLean, VA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 410-413.

Recommendations for enhancing human performance on an airship under consideration for maritime use by the U.S. Navy. The aim of the program is to study the airship's effectiveness in enhancing the offensive and defensive capabilities of various naval surface forces. It is concluded that a specifically sized crew can maintain acceptable levels of performance during airship missions of 30 to 60 day duration if an appropriate work/rest schedule is followed and minimum habitability requirements are met. B.J.

A88-35428

**DYNAMIC FUNCTION ALLOCATION IN FIGHTER COCKPITS**

ANTHONY J. ARETZ, JOSEPH C. HICKOX, and SUSAN R. KESLER (U.S. Air Force Academy, Colorado Springs, CO) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 414-418. USAF-supported research. refs

The objective of this study was to investigate alternatives for allocating the tasks associated with defensive countermeasures in a fighter cockpit environment. The three methods allocated the functions either totally to the operator or a simulated expert system and dynamically at the operator's request to either. The analysis of the objective data showed there were no significant performance differences among the three treatment conditions. However, the analysis of posttreatment subjective data showed the subjects did



have confidence in the simulated expert system's ability to handle the threats and they had a significant preference for some form of computer assistance during the missions. Author

#### A88-35430

##### AIRBORNE MESSAGE ENTRY BY VOICE RECOGNITION

CHRISTIAN P. SKRIVER (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 424-427.

This report presents the results of an experiment that measured performance in a simulated ASW message entry task with two modes of data input, vocal and manual. The subjects (Ss) were 12 Naval enlisted men. The independent variable was message data entry mode, vocal or manual. The dependent variables were: time to enter 20 lines of text, data entry errors that were corrected by the Ss, and errors that remained undetected. All Ss were trained to use the voice recognition system with a 100 word vocabulary set. The task was for the S to read one line of message text from a display and then reenter the text below the displayed text via either voice recognizer or keyboard until 20 lines of text had been entered. Keyboard entry was found to be slightly faster (11 percent) than voice recognition input. Author

A88-35431\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

##### INFORMATION TRANSFER IN PILOTS' USE OF A COLLISION AVOIDANCE SYSTEM

SHERYL L. CHAPPELL, BARRY C. SCOTT, and CHARLES E. BILLINGS (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 428-431.

A flight simulator study of pilots' use of the Traffic-alert and Collision Avoidance System is described. Three levels of information on the location of other air traffic were presented to different groups of airline pilots. The amount of information on the location of other traffic had little effect on pilots' performance of the maneuvers commanded by the collision avoidance system. Measured crew responses were similar with no presentation of traffic location, with limited information, and with continuous traffic information. No learning effects were observed, and differences in flight experience did not contribute to the performance difference found. B.J.

#### A88-35435

##### EFFECTS OF VISUAL DISPLAY AND MOTION SYSTEM DELAYS ON OPERATOR PERFORMANCE AND UNEASINESS IN A DRIVING SIMULATOR

LAWRENCE H. FRANK, JOHN G. CASALI, and WALTER W. WIERWILLE (Virginia Polytechnic Institute and State University, Blacksburg) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 492-496. refs

#### A88-35439

##### THE EFFECTS OF MODALITY AND STRESS ACROSS TASK TYPE ON HUMAN PERFORMANCE

KENNETH L. PAMPERIN and CHRISTOPHER D. WICKENS (Illinois, University, Savoy) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 514-518. refs  
(Contract DAAA15-86-K-0013)

This investigation integrates four different approaches to the study of attention and multiple task performance, to include the effects of stimulus modality presentation, the influence of spatial separation in visual stimulus presentation, the effects of stress, and the influence of task type (dual-task versus information-integration task), in a spatial vector monitoring task. A significant benefit of cross-modal (visual-auditory) presentation was found when information was integrated at both levels of stress,

while an interaction between modality and stress level occurred in the dual task condition, favoring the intra-modal (visual-visual) presentations at the lower stress level. The auditory display tended to be more stress resistant. The results support Kahneman's (1973) concept of stress-related resource expansion, provide weak support for perceptual narrowing, and provide little support for a processing modalities dimension of the Multiple Resource Model. Author

A88-35444\* Illinois Univ., Urbana-Champaign.

##### ATTENTION THEORY AND TRAINING RESEARCH

JAMES G. CONNELLY, JR., CHRISTOPHER D. WICKENS, GAVAN LINTERN, and KELLY HARWOOD (Illinois, University, Urbana) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 648-651. Sponsorship: 0. refs  
(Contract NAG2-308)

This study used elements of attention theory as a methodological basis to decompose a complex training task in order to improve training efficiency. The complex task was a microcomputer flight simulation where subjects were required to control the stability of their own helicopter while acquiring and engaging enemy helicopters in a threat environment. Subjects were divided into whole-task, part-task, and part/open loop adaptive task groups in a transfer of training paradigm. The effect of reducing mental workload at the early stages of learning was examined with respect to the degree that subordinate elements of the complex task could be automated through practice of consistent, learnable stimulus-response relationships. Results revealed trends suggesting the benefit of isolating consistently mapped sub-tasks for part-task training and the presence of a time-sharing skill over and above the skill required for the separate subtasks. Author

#### A88-35445

##### HIGH PERFORMANCE COGNITIVE SKILL ACQUISITION - PERCEPTUAL/RULE LEARNING

ARTHUR D. FISK (Georgia Institute of Technology, Atlanta) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 652-656. refs  
(Contract F30602-81-C-0193)

Two experiments examined the effects of inter-component consistency on skill acquisition in a class of cognitive demanding tasks requiring rapid integration of information as well as rapid application of rules. The role of consistency of external stimulus-to-rule linkage in facilitating the learning and performing of a rule-based classification task was examined. The present data have implications for the understanding and training of skilled problem solving tasks. When training allows the development of automatization of subcomponents of the problem solving activity, the chance of memory overload is reduced. The present data point to one such trainable subcomponent clearly present in most real-world problem solving situations - the perceptual and rule-based components. Author

#### A88-35446

##### INSTRUCTION FOR MILITARY AIR INTERCEPT CONTROL

LISA F. WEINSTEIN (Illinois, University, Savoy) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 662-666. Navy-supported research. refs

A microcomputer-based simulation method with options for (1) part-task training, (2) time-compressed training, and (3) spatial visualization of the intercept problem is developed to instruct novice air-intercept controllers in the basic operational tasks required by the U.S. Navy Tactical Data System. The effectiveness of the system is evaluated experimentally by varying the simulation components and conditions and then testing student performance in the full real-time simulation. The results are obtained with (1), (2), and (3) are found to be significantly better than with full-simulation training and algebraic calculation of intercept bearings. In a second experiment, it is shown that (2) is much more important than (1) in improving the effectiveness of the training. T.K.

**A88-35447\*** Illinois Univ., Urbana-Champaign.

**CROSS-MODAL INTERFERENCE AND TASK INTEGRATION - RESOURCES OR PREEMPTION SWITCHING?**

CHRISTOPHER D. WICKENS, LEE FRACKER, and JAYSON WEBB (Illinois, University; Urbana) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 679-683. refs  
(Contract NAG2-308)

Data are reviewed from experiments that have contrasted intra-modal (visual-visual) information presentation with cross-modal (visual-auditory) presentation. Five different processing mechanisms that are operating in dual stimulus tasks are described, and it is concluded that in studies where visual scanning is not required, cross-modal effects are of two classes. When the visual task is continuous (tracking), a discrete auditory stimulus will preempt tracking performance relative to a discrete visual stimulus, leading to an effective shift in allocation bias. When both tasks are discrete, the data regarding the relative advantages of cross-modal vs. intra-modal interference are ambivalent. Author

**A88-35448**

**PHYSIOLOGICAL CORRELATES OF BEHAVIORAL PERFORMANCE ON THE MATHEMATICAL PROCESSING SUBTEST OF THE CTS BATTERY**

ROBERT L. YOLTON (Pacific University, Forest Grove, OR), GLENN WILSON (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH), IRIS DAVIS, and KATHY MCCLOSKEY (Systems Research Laboratories, Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 770-773. refs  
(Contract F49620-85-C-0013)

Experiments were conducted using the mathematical processing subtest of the Criterion Task Set battery to demonstrate that the three levels built into the subtest produce different work loads which, in turn, produce different levels of physiological responses in human subjects. Following extensive training, ten adult subjects were asked to solve equations with one, two, and three plus or minus operators. Reaction times and subjective work-load ratings were found to increase with the number of operators in the equations, whereas the EEG's P-300 event-related potential was found to decrease in amplitude and to increase in latency. On the other hand, the heart rhythm, the eye blinks, and the peripheral temperature parameters showed no systematic relationships to the number of operators. I.S.

**A88-35449**

**EVALUATING A SPATIAL TASK - BEHAVIORAL, SUBJECTIVE, AND PHYSIOLOGICAL CORRELATES**

KATHY MCCLOSKEY (Systems Research Laboratories, Inc.; Wright State University, Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 774-778. refs

The effect of task load on physiological parameters was investigated using a spatial task subset taken from the Criterion Task Set battery. The task event-related potentials (EPs) of the EEG recordings, the heart rhythm and its variance, the temperature, and the eye-blink indices were obtained while the subjects performed the three levels of the math processing task. Subjective ratings of perceived work load associated with each operator level were also obtained using the Subjective Work-load Assessment technique (SWAT) of Reid et al. (1985). For the EP data, the patterns of the components for both the occipital and occipital-parietal areas were found to differentiate between the low task level and the medium and high, whereas medium and high task levels did not differentiate, indicating by this criterion that the spatial task does not possess three levels of task load. The eye blink measures, the heart rate, and the heart rate variability did not differentiate between any task levels. I.S.

**A88-35450**

**PHYSIOLOGICAL DATA USED TO MEASURE PILOT WORKLOAD IN ACTUAL FLIGHT AND SIMULATOR CONDITIONS**

GLENN F. WILSON, BRAD PURVIS, JUNE SKELLY (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH), PENNY FULLENKAMP, and IRIS DAVIS (Systems Research Laboratories, Inc., Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 779-783. refs

Three physiological measures of workload; heart rate, eye blink, and EEG were recorded from eight experienced A-7 attack aircraft pilots. Each pilot flew the same familiar training mission three times; one mission in the lead position of a four ship formation and the other as wing, and once in an A-7 simulator. The mission lasted approximately 90 minutes and consisted of take-off, low altitude terrain following, high G maneuvers, inflight navigational updates, weapons delivery, and a high altitude cruise to base, ending in a formation landing. The data show significant differences between simulated and actual flights for all measures. There were also significant differences between mission segments for each pilot. The heart rate data most obviously reflect the changes in workload level throughout the mission and between flight position and simulator. Blink rate and duration were sensitive to changing visual attentional demands. The EEG data showed differences between the actual flight missions and the simulator. Author

**A88-35451**

**HEART RATE AVERAGES AS WORKLOAD/FATIGUE INDICATORS DURING OT&E**

STEPHEN M. ROKICKI (USAF, Operational Test and Evaluation Center, Kirtland AFB, NM) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 784, 785.

A methodology was developed, which allows a macrolevel assessment of aircrew work load during long-duration test flights without interfering with aircrew duties or imposing nonmission work load. Using heart rate changes as an indicator of mental state changes during flight, and the answers obtained from crewmembers in postflight interviews, the heart rate changes were correlated with task and environmental stresses experienced during particular time segments. The results of this tests were found to highlight some unanticipated work-load areas for further evaluation. The major limitation of the test is the individual differences in responses to mental arousal. I.S.

**A88-35458\*** Battelle Memorial Inst., Seattle.

**MEASURING PILOT WORKLOAD IN A MOTION BASE SIMULATOR. III - SYNCHRONOUS SECONDARY TASK**

BARRY H. KANTOWITZ (Battelle Memorial Institute, Seattle, WA), MICHAEL R. BORTOLUSSI (Western Aerospace Laboratories, Inc., Moffett Field, CA), and SANDRA G. HART (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 834-837.

(Contract NCC2-228)

This experiment continues earlier research of Kantowitz et al. (1983) conducted in a GAT-1 motion-base trainer to evaluate choice-reaction secondary tasks as measures of pilot work load. The earlier work used an asynchronous secondary task presented every 22 sec regardless of flying performance. The present experiment uses a synchronous task presented only when a critical event occurred on the flying task. Both two- and four-choice visual secondary tasks were investigated. Analysis of primary flying-task results showed no decrement in error for altitude, indicating that the key assumption necessary for using a choice secondary task was satisfied. Reaction times showed significant differences between 'easy' and 'hard' flight scenarios as well as the ability to discriminate among flight tasks. Author

A88-35459

**THE EFFECT OF EXPERIENCE ON SUBJECTIVE RATINGS FOR AIRCRAFT AND SIMULATOR WORKLOAD DURING IFR FLIGHT**

CARL J. MALLERY (Ohio State University, Columbus) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 838-841. FAA-supported research.

This research is the result of a need to evaluate the effect of new complex cockpit systems on pilot workload. The goal of this research is to determine if the Pilot Objective/Subjective Workload Assessment Technique (POSWAT) ratings of workload obtained in a simulator are comparable to ratings obtained in an aircraft. In this study, twenty experienced instrument rated subject pilots flew the same three simulated instrument cross-country flights. During these flights the pilots gave POSWAT workload ratings at one-minute intervals. The results show that, in general, increased experience decreases POSWAT workload ratings for a given taskload. Author

A88-35460

**A COMPONENTIAL ANALYSIS OF PILOT DECISION-MAKING**

B. BARNETT, A. STOKES, C. D. WICKENS, T. DAVIS, R. ROSENBLUM (Illinois, University, Savoy) et al. IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 842-846. refs  
(Contract F33615-85-D-0514)

In an effort to construct and validate an information-processing model of pilot decision-making, a microcomputer-based system, known as MIDIS, has been developed. A parallel effort resulted in the compilation of a cognitive test battery designed to assess individual differences in those cognitive attributes determined to be important in effective decision-making. The processing model of pilot judgment is validated to the extent that pilots with strengths in particular cognitive attributes perform well on those decision scenarios determined to impose demands on those same abilities. Forty professional, instructor, and student pilots served as subjects in this validation study. The results reported here represent data from twenty of the highly-experienced instrument-rated pilots. The results indicated that the cognitive test of running memory span provided a valid predictor of the optimality of pilot's judgments. A test of risk assessment predicted pilot confidence and latency in the decision choices. Few of the other tests, including a test of declarative knowledge, provided significant correlations with the three attributes of decision performance for the pilots in the group studied to date. Author

A88-35461\* Illinois Univ., Urbana-Champaign.

**THE EFFECT OF PROCESSING CODE, RESPONSE MODALITY AND TASK DIFFICULTY ON DUAL TASK PERFORMANCE AND SUBJECTIVE WORKLOAD IN A MANUAL SYSTEM**

YILI LIU and CHRISTOPHER D. WICKENS (Illinois, University, Urbana) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 847-851. refs  
(Contract NAG2-308)

This paper reports on the first experiment of a series studying the effect of task structure and difficulty demand on time-sharing performance and workload in both automated and corresponding manual systems. The experimental task involves manual control time-shared with spatial and verbal decisions tasks of two levels of difficulty and two modes of response (voice or manual). The results provide strong evidence that tasks and processes competing for common processing resources are time shared less effectively and have higher workload than tasks competing for separate resources. Subjective measures and the structure of multiple resources are used in conjunction to predict dual task performance. The evidence comes from both single-task and from dual-task performance. Author

A88-35464

**THE INTERACTION OF BOTTOM-UP AND TOP-DOWN CONSISTENCY IN THE DEVELOPMENT OF SKILLS**

NATALIE A. ORANSKY, PAULA R. SKEDSVOLD (South Carolina, University, Columbia), and ARTHUR D. FISK (Georgia Institute of Technology, Atlanta) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1044-1048. refs

(Contract F30602-81-C-0193)

An experiment is reported that was conducted to examine the possible value of higher-order consistency in skill development. Subjects made judgments about ordinal properties of stimuli. The presence or absence of consistency was defined by the type of decision -- consistent or varied decisions. In both decision conditions the stimuli were inconsistent at the individual stimulus level; however, subjects making consistent decisions concerning the stimuli could make use of consistent relationships among the stimuli. Subjects in the consistent decision were faster and more accurate at identifying target stimuli when compared with the inconsistent decision subjects. In addition to the quantitative differences, subjects receiving consistent decision training were qualitatively different in performance when compared to the inconsistent decision group. The pattern of results from the present experiment is quite consistent with previous memory/visual search investigations. The experiment supports the suggestion that local level (or stimulus based) consistency is not necessary for automatic process development if task relevant higher-order (or global) consistency can be identified and used by the trainees. Author

A88-35465\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**ABSOLUTE MAGNITUDE ESTIMATION AND RELATIVE JUDGEMENT APPROACHES TO SUBJECTIVE WORKLOAD ASSESSMENT**

MICHAEL A. VIDULICH (NASA, Ames Research Center, Moffett Field, CA) and PAMELA S. TSANG (Illinois, University, Urbana) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1057-1061. refs

Two rating scale techniques employing an absolute magnitude estimation method, were compared to a relative judgment method for assessing subjective workload. One of the absolute estimation techniques used was an unidimensional overall workload scale and the other was the multidimensional NASA-Task Load Index technique. Thomas Saaty's Analytic Hierarchy Process was the unidimensional relative judgment method used. These techniques were used to assess the subjective workload of various single- and dual-tracking conditions. The validity of the techniques was defined as their ability to detect the same phenomena observed in the tracking performance. Reliability was assessed by calculating test-retest correlations. Within the context of the experiment, the Saaty Analytic Hierarchy Process was found to be superior in validity and reliability. These findings suggest that the relative judgment method would be an effective addition to the currently available subjective workload assessment techniques. Author

A88-35466

**A CONFIRMATORY FACTOR ANALYTIC INVESTIGATION OF TIME SHARING PERFORMANCE AND COGNITIVE ABILITIES**

JEFFREY B. BROOKINGS (Wittenberg University, Springfield, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1062-1066. refs  
(Contract F33615-85-D-0514)

Eighty-one male subjects performed four information processing tasks and six dual task combinations, and completed a battery of psychometric ability tests selected to define three first-order factors and a second-order general ability factor. Confirmatory maximum likelihood factor analyses of the performance data provided no support for a general time-sharing factor, but a model with factors corresponding to the four single tasks provided a good fit to the data. The Grammatical Reasoning factor was highly correlated

with the Verbal and second-order General Ability factors, suggesting that this task may be a good single index of total attentional resources. Author

### A88-35473

#### FURTHER INVESTIGATION OF CONTRAST SENSITIVITY AND VISUAL ACUITY IN PILOT DETECTION OF AIRCRAFT

MELVIN R. O'NEAL (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) and ROBERT E. MILLER, II (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1189-1193. refs

Previous studies on contrast sensitivity (CS) testing of pilots have demonstrated a lack of consistency for correlations of detection with the CS at any particular spatial frequency. In the present study, 67 USAF pilots, divided into eight groups isolated in a bus near the end of a runway, were asked to detect a white T-36 jet aircraft at 1000 feet altitude and 200 mph airspeed during the target detection phase of eight landings in the partly-cloudy to cloudy conditions. The levels of CS were measured using the criterion-free two-alternative temporal forced-choice technique on the Optronix and with the Vistech VCTS 6500 chart. Visual acuity was assessed at three contrast levels using 3, 6, and 85 percent contrast Regan charts. It was found that neither CS nor visual acuity correlated well with the detection by the pilot of the actual aircraft. Overall, visual acuity was much better than CS at identifying the worse detection individuals. I.S.

### A88-35474

#### CONTRAST SENSITIVITY AS A PREDICTOR OF COMPLEX TARGET DETECTION

DAVID SHINAR and EHUD GILEAD (Negev, University, Beersheba, Israel) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1194-1197. refs

A class of undergraduate students were screened for their visual acuity and contrast sensitivity on Ginsburg's charts. The subjects obtaining the highest and lowest contrast sensitivity scores were further tested on their complex target detection time. The complex targets consisted of a tank or a human form against a background of a mountainous terrain. The main finding was that target detection time for the high contrast sensitivity subjects was less than half of that of the low contrast sensitivity subjects. Differences in visual acuity between the two groups did not explain the differences in reaction time. Author

### A88-35478

#### COGNITIVE PROCESSES DURING INSTRUMENT LANDING

THOMAS J. HIGGINS (Lockheed-California Co., Burbank; Southern California, University, Los Angeles, CA) and MARK H. CHIGNELL (Southern California, University, Los Angeles, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1216-1220. refs

Applications of artificial intelligence (AI) in the cockpit require a deeper understanding of the cognitive processes of the pilot. This paper describes ongoing research concerned with developing cognitive models of pilot behavior that can support the development of expert systems and machine reasoning within the cockpit. An experiment is reported where the behavior of pilots within a flight simulator is observed. Verbal instructions given by the controlling pilot in a 'division of labor' task are used to identify salient features of pilot cognitive models of the task. The results of this experiment are interpreted in terms of their implications for the development of future expert systems within the cockpit. Continued research on the cognitive models used by pilots should permit the development of a knowledge base that will assist display design, training programs, and research on mental workload within the cockpit. Author

### A88-35481

#### TRAINING DEVELOPMENT FOR COMPLEX COGNITIVE TASKS

JOAN M. RYDER, RICHARD E. REDDING, and PETER F. BECKSCHI (Pacer Systems, Inc., Horsham, PA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1261-1265. USAF-supported research. refs

The Instructional Systems Development (ISD), introduced as a military training methodology in the 1970's and based on psychological principles derived mainly from behaviorism, was adequate for training for tasks with fixed procedural sequences and largely psychomotor skills. This paper evaluates the applicability of ISD to the design of training required for advanced aircraft operators and compares the principles and procedures of the ISD with recently developed training methodologies in order to determine how recent developments in cognitive science can be applied to ISD to modify the training procedures for tasks which require complex cognitive skills. It is concluded that the ISD is still viable if the cognitive approach is used. While the traditional approaches leave later stages of training (automation and fine tuning of skills) to be accomplished on the job, a cognitive approach would concentrate on developing automated skill component practice and skill refinement to build higher levels of expertise. I.S.

### A88-35485

#### THE EFFECTS OF SIMULATOR DELAYS ON THE ACQUISITION OF FLIGHT CONTROL SKILLS - CONTROL OF HEADING AND ALTITUDE

GARY E. RICCIO (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH), JEFFREY D. CRESS, and WILLIAM V. JOHNSON (Systems Research Laboratories, Inc., Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1286-1290.

The effects of simulator delays on performance, control behavior, and transfer of training were investigated with a group of subjects who had no experience with flight control tasks. Two types of aircraft were simulated: one with highly responsive dynamics and one with sluggish dynamics. Subjects were assigned to one of four time-delay conditions and to one of the two aircraft types. In the first phase of the experiment, subjects participated in fifty trials (ten trials per day) with a particular time delay (50, 100, 200, or 400 milliseconds). After this 'training' phase, all subjects 'transferred' to the minimum time-delay condition (50 milliseconds) for another fifty trials. The experimental task required that the subjects maintain constant heading and altitude in the presence of pseudo-random roll-rate and pitch-rate disturbances. There were statistically significant effects of time delay on root-mean-square heading and altitude errors in both the training and transfer phases of the experiment. The effect of delay on transfer of training was greater for the aircraft with sluggish dynamics. Author

### A88-35486

#### FLIGHT SIMULATION TRAINING USING STANDARD AND NON-STANDARD TASKS

KIMBERLY A. REARDON, CELIA G. OLIVER (Systems Research Laboratories, Inc., Dayton, OH), and RIK WARREN (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1291-1295.

In previous visual-simulation studies of pitch control during low-altitude high-speed flight, using dots displays of perspective view of a roadway, it was found that performance deteriorated appreciably at altitudes below 50 ft, with near-ground flight resulting in optically violent displays. In this paper, the potential efficacy of nonstandard simulated flying (that at a zero-altitude and even below ground) for improving the performance of the low above-ground

flight tests was investigated. It was found that neither zero-altitude training with the dots display nor the combined display (in which a horizon line and perspective roadway were superimposed on the random dot texture gradient) produced improved performance during the low-altitude task, indicating that the advantages of the zero-altitude training were masked by the negative effects of transferring from the zero altitude task to the low altitude task.

I.S.

A88-35488

**QUANTIFYING SOME INFORMATION PROCESSING REQUIREMENTS OF THE PILOT'S INSTRUMENT CROSSCHECK**

JOSEPH L. BUNECKE (Massachusetts, University, Amherst) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1301-1305. refs

Previous research concerning the pilot's visual scan is descriptive/ predictive in nature. This experiment quantitatively demonstrates the information processing aspects of one instrument monitoring technique. The results imply that experienced pilot eye movement patterns reflect workload minimization strategies developed early during flight training.

Author

A88-35491\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PART-TASK VS. WHOLE-TASK TRAINING ON A SUPERVISORY CONTROL TASK**

VERNO BATTISTE (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1365-1369. refs

The efficacy of a part-task training for the psychomotor portion of a supervisory control simulation was compared to that of the whole-task training, using six subjects in each group, who were asked to perform a task as quickly as possible. Part-task training was provided with the cursor-control device prior to transition to the whole-task. The analysis of both the training and experimental trials demonstrated a significant performance advantage for the part-task group: the tasks were performed better and at higher speed. Although the subjects finally achieved the same level of performance in terms of score, the part-task method was preferable for economic reasons, since simple pretraining systems are significantly less expensive than the whole-task training systems.

I.S.

A88-35492

**EVALUATION OF TOTAL CONTRACT TRAINING (TCT) SYSTEMS**

JERRY M. CHILDS (BDM Corp., Albuquerque, NM) and BRUCE A. SMITH (Singer Co., Simulation Div., Binghamton, NY) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1370-1372.

The Total Contract Training (TCT) system used for air and ground training of aircraft crew is described. The TCT is designed to produce trainees with a predetermined level of proficiency, achieved by defining, exploiting, and managing all training resources and by documenting trainee's progress relative to explicit training objectives. The paper gives special attention to factors to be addressed in the evaluation of TCT systems.

I.S.

A88-35693

**PROBLEMS IN THE PSYCHOLOGICAL EVALUATION OF MILITARY FLIGHT PERSONNEL (PROBLEMS POSES PAR L'EXPERTISE PSYCHOLOGIQUE DU PERSONNEL NAVIGANT MILITAIRE)**

G. SOLIGNAC (Centre Principal d'Expertise Medicale du Personnel Navigant, Paris, France), J. B. DENIS, J. C. DUBOIS-BONNEFOND, and J. R. GALLE-TESSONNEAU (Centre Medical de Psychologie Clinique de l'Armee de l'Air, Paris, France) Medecine Aeronautique et Spatiale, vol. 26, 3rd Quarter, 1987, p. 254-260. In French. refs

The notions of psychological motivation, adaptability, and fitness are reviewed, and issues related to the determination of psychological fitness for flight personnel are considered. The characteristics of the psychological examination are compared with those of the physical examination. The psychological examination involves both tests of cognitive and psychomotor ability, and more general assessments of the individual's psychological condition. Conditions frequently encountered among flight trainees are loss of motivation and air sickness. Conditions encountered among trained pilots include depression, fatigue, and posttraumatic guilt or anxiety.

R.R.

A88-35697

**PSYCHOLOGY AND AIRCRAFT ACCIDENTS [PSYCHOLOGIE ET ACCIDENTS D'AVIONS]**

G. VERON (Centre d'Etudes et de Recherches Psycho-Technique, Saint-Cyr l'Ecole, France) Medecine Aeronautique et Spatiale, vol. 26, 4th Quarter, 1987, p. 320-322. In French.

Systematic means of identifying the chain of incidents and poor pilot responses leading up to human-error-related aircraft accidents (which constitute 70 percent of all aircraft accidents) are explored. Pilot inattention is cited as the most frequent cause of pilot error. Causal analyses following the accident involve the use of multidimensional statistical methods. 'Before-accident' analyses involve the investigation of both near accidents and aircraft incidents. Two models are considered, one describing the man-aircraft interface and one describing the interfaces between man, the aircraft, and the environment.

R.R.

A88-35699

**PSYCHOPATHOLOGY AND AIR FORCE FLIGHT SAFETY [PSYCHOPATHOLOGIE ET SECURITE DES VOLS EN AERONAUTIQUE MILITAIRE]**

J. R. GALLE-TESSONNEAU (Armee de l'Air, Centre Medical de Psychologie Clinique, Paris, France) and G. SOLIGNAC (Centre Principal d'Expertise Medicale du Personnel Navigant, Paris, France) Medecine Aeronautique et Spatiale, vol. 26, 4th Quarter, 1987, p. 328-331. In French.

Psychological data on air force pilots are used to examine the contribution of the study of psychopathology to flight safety. Types of anxiety such as the fear of death are discussed. Implications of the study of the psychopathology of military personnel for the military selection process and for the role of the military doctor are considered. The possible beneficial roles of biofeedback and group therapy in maintaining pilot psychological health are also discussed.

R.R.

A88-36173

**PSYCHOLOGICAL PROBLEMS OF COMPUTERIZING SCIENTIFIC RESEARCH PROJECTS [PSIKHOLOGICHESKIE PROBLEMY AVTOMATIZATSII NAUCHNO-ISSLEDOVATE'SKIKH RABOT]**

M. G. IAROSHEVSKII, ED. and O. K. TIKHOMIROV, ED. Moscow, Izdatel'stvo Nauka, 1987, 240 p. In Russian. No individual items are abstracted in this volume.

This book discusses the psychological aspects of using computer technology in scientific research, with emphasis placed on special problems that arise upon the introduction of the computer. Attention is given to optimal conditions for the productivity of computerized scientific research. The difficulties and the problems arising in the course of computer-connected activity are discussed together with the effect of these difficulties on the psychological status of the program-user. Special consideration is given to the problems of man-computer interaction, the intellectual strategies and individual styles used in the man-computer dialogue, and the psychological defenses used against automatically following computer-set strategies.

I.S.

A88-36712#

**PREVIEW CONTROL PILOT MODEL FOR NEAR-EARTH MANEUVERING HELICOPTER FLIGHT**

R. A. HESS (California, University, Davis) and K. K. CHAN (Guidance, Navigation and Control Conference, Williamsburg, VA,



Aug. 18-20, 1986, Technical Papers, p. 875-885) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 11, Mar.-Apr. 1988, p. 146-152. Previously cited in issue 23, p. 3481, Accession no. A86-47498. refs

**N88-20819** New South Wales Univ., Kensington (Australia). **COMPUTERISED MEASUREMENT OF HUMAN HORIZONTAL SMOOTH PURSUIT EYE MOVEMENTS Abstract Only. M.S. Thesis**

M. J. TODD Mar. 1987 249 p

Avail: Issuing Activity

Smooth pursuit is one type of compensatory eye movement which maintains gaze on a moving target and ensures clear vision. There is clinical evidence that abnormalities of pursuit are an early and sensitive index of brain disease and measurement of smooth pursuit responses could be important for diagnosis and for assessment of progress and treatment. Clinical testing so far has measured only steady-state pursuit responses to predictable target motion but recent research in monkeys has indicated that the response to transient stimuli may be clinically more significant. The development of a computerized system for generating precisely controlled transient smooth pursuit stimuli and for accurately recording and analyzing the eye movements produced are described. The type of target motion used was a step-ramp, first described by Rashbass in 1961. Clinical tests of the final system showed that it performs as well as the best contemporary systems in the world for recording smooth pursuit transients and that it is a useful tool for intensively studying the normal and abnormal responses to these stimuli. Author

**N88-20820#** Decision Science Consortium, Inc., Falls Church, Va.

**A PERSONALIZED AND PRESCRIPTIVE DECISION AID FOR CHOICE FROM A DATABASE OF OPTIONS Final Technical Report, Jul. 1983 - Sep. 1986**

MARVIN S. COHEN, KATHRYN B. LASKEY, and MARTIN A. TOLCOTT 23 Nov. 1987 71 p

(Contract N00014-83-C-0485; PROJ. F66-701)

(AD-A188726; DSCI-87-18) Avail: NTIS HC A04/MF A01 CSCL 05H

In many decision making contexts there is a need for aids which cater flexibly to individual users in their preferred ways of organizing information and solving problems, but which guard against potential errors or biases inherent in common approaches to decision making. DSC has developed principles of personalized and prescriptive decision aiding which respond to this need, and which are based on experimental findings and theoretical models in cognitive psychology. In Phase 1 of this project, those principles were applied to the development of an aid for attack submarine approach and attack. In Phase 2, the principles have been generalized and extended to the development of a generic personalized and prescriptive evaluation system. The system incorporates five basic cognitive interface modules to customize the user's interaction with the aid to provide prescriptive guidance, as well as a set of interactive dialogues or guides which blend all five functions in support of specific user-selected decision-making strategies. The aid has been tested and demonstrated in the context of a personnel application. GRA

**N88-20821#** Katholieke Universiteit, Nijmegen (Netherlands). Psychologisch Lab.

**DISTRACTION AND INHIBITION IN CONTINUOUS CRT PERFORMANCE: A REPLICATION AND SOME NEW FINDINGS**

R. W. T. L. JANSEN and G. J. P. VANBREUKELLEN 1987 37 p (PB88-150941; REPT-87-MA-01) Avail: NTIS HC A03/MF A01 CSCL 05I

The present study replicates findings of van Breukelen and Jansen (1987) concerning the role of distractions and inhibition in response times, but using a different task. The distraction hypothesis states that a fair amount of the reaction time consists of distraction, i.e., time not serving the task performance. The inhibition hypothesis states that the tendency of being distracted increases during mental processing time and decreases during

distraction. An experimental comparison of massed (continuous work) versus spaced (work with regular resting periods) served to test the two main hypotheses. Subjects were 16 male and 16 female student volunteers. A digit addition task was used. The experimental setting was as in van Breukelen and Jansen (1987). Specific predictions were derived from the inhibition model of Van der Ven, Smit, and Jansen (1987). The results supported most of these predictions. Furthermore, a few explorative analyses are reported concerning learning effects. Finally, the task independence of speed, error rate and concentration was explored by calculating correlations between the corresponding conditions of the van Breukelen and Jansen (1987) and the present experiment with respect to these variables. All correlations were significant, varying between .40 and .80. GRA

**N88-21636#** Technische Hogeschool Twente, Enschede (Netherlands).

**QUASI-LOGLINEAR MODELS FOR TEST AND ITEM ANALYSIS Ph.D. Thesis**

HENDRIKUS KELDERMAN 1987 187 p

(B8716249; ETN-88-91838) Avail: NTIS HC A09/MF A01

The connection between discrete data analysis by the use of loglinear models and the item-response model of Rasch (1960, 1966) is studied. It is shown that the dichotomous Rasch model can be formulated as a certain quasi-loglinear model. This yields a methodological framework to test the Rasch model and to apply it to practical measurement problems. An algorithm that can handle data sets of real life size was developed. The quasi-loglinear Rasch model is applied to two psychometric problems, the detection of biased items and the equating of test. ESA

**N88-21637#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Hamburg (West Germany). Abteilung Luft- und Raumfahrtpsychologie.

**CONSTRUCTION OF A MULTIDIMENSIONAL QUESTIONNAIRE TO DETERMINE INTERINDIVIDUAL DIFFERENCES IN CONTROLLING ATTENTION**

REINHOLD MERGENTHAL Oct. 1987 61 p In GERMAN; ENGLISH summary

(DFVLR-FB-87-45; ISSN-0171-1342; ETN-88-92114) Avail: NTIS HC A04/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, 20.50 Deutsche marks

A questionnaire on work behavior was constructed in order to isolate parameters of work style which may correlate with the occurrence or the avoidance of human errors. The philosophy behind the questions and analysis of the responses are discussed. ESA

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### MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

**A88-33124**

**HUMAN OCCUPATIONAL AND INDUSTRIAL VIBRATION**

DONALD E. WASSERMAN (Anatrol Corp., Cincinnati, OH) Journal of Environmental Sciences (ISSN 0022-0906), vol. 31, Mar.-Apr. 1988, p. 58-62. refs

The medical/epidemiological and engineering aspects of both whole-body and hand-arm occupational/industrial vibration are discussed. Eight million workers in the U.S. are exposed to occupational vibration. Current hand-arm and whole-body vibration standards are also presented, along with engineering control and work practice recommendations for minimizing worker exposure to vibration. Author

A88-33589

**THE EFFECT OF TWO LIGHTING CONDITIONS ON PERFORMANCE OF THE FARNSWORTH LANTERN COLOR VISION TEST**

STEPHEN J. DAIN, VANESSA HONSON, B. OPTOM, and JOVINA ANG (New South Wales, University, Kensington, Australia) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 59, April 1988, p. 371-373. refs

This paper compares the performance of color-defective patients during the Farnsworth Lantern test in both unlit and lit room conditions. Eighteen dichromats and 33 anomalous trichromats, as diagnosed by the Mark I Nagel Anomaloscope were examined. No statistically significant differences were found between their performance under the two conditions. Author

A88-33795#

**SHOWER WATER CHARACTERIZATION TESTS**

GERALD A. WHITMAN and SAM S. WOODWARD (Boeing Aerospace Co., Seattle, WA) IN: Aerospace Testing Seminar, 10th, Los Angeles, CA, Mar. 10-12, 1987, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1987, p. 195-198.

Tests required to characterize shower water for recycling within the confines of the Space Station are discussed. On the basis of this characterization, a model was developed to supply the water necessary for the development and testing of the water recycling equipment. The shower water characterization program involved 12 test subjects taking 112 showers to provide the samples for 1428 chemical and 224 microbiological tests. K.K.

A88-34063

**LEGIBILITY OF A CRT COLOR-MAP DISPLAY IN BRIGHT SUNLIGHT**

V. ALAN SPIKER, STEVEN P. ROGERS, and JOSEPH G. CIGINELLI (Anacapa Sciences, Inc., Santa Barbara, CA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 241-246. refs  
(Contract DAAB07-85-C-F036)

The legibility of colored symbology on a CRT map display was evaluated under simulated daylight. One experiment tested the identifiability of the map's six line colors (white, green, yellow, pink, cyan, red). A second experiment assessed the identifiability and legibility of the map's three point symbol colors (white, red, yellow). In each experiment, the intensity of the ambient daylight was varied from 5-13 times greater than the total (white) display luminance. Results showed that the legibility of most CRT colors degraded once the veiling luminance in the cockpit exceeds display luminance by a factor of 5-10. Smaller symbols and dimmer colors (e.g., red) become degraded once the veiling/display luminance ratio exceeds 5:1. Larger and more luminant features (white, green) remain legible until the ratio exceeds 10:1. These results underscore the need to consider subtle luminance/chromaticity tradeoffs when using colors to code airborne displays. I.E.

A88-34097#

**IMPROVING PILOT-VEHICLE INTEGRATION USING COCKPIT DISPLAY DYNAMICS**

LISA B. MCCORMACK, MARK J. DETROIT, and DOUGLAS N. SEE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 530-536. refs

Flight control designers need analytic guidelines for developing and retrofitting operational aircraft to obtain acceptable display dynamics. The authors report on developing these guidelines for use in the preliminary design process and, ultimately, to more fully integrate the crew and vehicle. Two experiments have been conducted to generate a database on the effects of cockpit display dynamics. The display time delays investigated usually affected

pilot stick force, but had little impact on rms error. The added time delay increased pilot stick activity but did not markedly degrade performance, which may indicate increased workload. I.E.

A88-34143#

**THE DEVELOPMENT AND STATUS OF A ROBUST SPEECH RECOGNITION DATA BASE**

MARK A. ERICSON (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 882-888. refs

The author describes the development of the DARPA robust speech database, the facilities used to collect it, the simulated environmental conditions, the database configurations, the progress and the status at the present time. Preselected speech is produced by experienced aircraft pilots under simulated harsh fighter aircraft environmental conditions. This stressed speech comprises the database that can serve to provide benchmark performance of speech recognition systems and to further the research of efforts of environmental stressors on speech. I.E.

A88-34144

**PHONETIC DISCRIMINATION (PD-100) TEST FOR ROBUST SPEECH RECOGNITION**

CAROL A. SIMPSON (Psycho-Linguistic Research Associates, Woodside, CA) and JOHN C. RUTH (McDonnell Douglas Electronics Co., Saint Charles, MO) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 889-896. refs

A rigorous phonetic discrimination test that can be used to compare recognizers and to predict the performance of individual recognizers for specific operational vocabularies is described. Preliminary results obtained with two connected word speaker-dependent recognizers compared to a human listener are reported. On the basis of these preliminary data, the phonetic discrimination test appears to be a sensitive and reliable instrument for measuring speech recognition algorithm performance. I.E.

A88-34145#

**SPEECH TECHNOLOGY IN THE FLIGHT DYNAMICS LABORATORY**

DAVID T. WILLIAMSON, RONALD L. SMALL, and GREGORY L. FEITSHANS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 897-900.

Over the past several years, the flight dynamics laboratory at Wright-Patterson Air Force Base has been actively involved in the investigation of the role of speech technology in US Air Force cockpits. The authors provide a summary of progress to date and also discuss the future direction of speech technology applications research within the flight dynamics laboratory. I.E.

A88-34146#

**DEFINITION EFFORTS IN COCKPIT AUTOMATION TECHNOLOGY (CAT) DEVELOPMENT**

LISA GUADAGNA, ARIC TURNER (USAF, Washington, DC), and KIM MAZUR (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 902-912. refs

In order to rectify the concentration of crew system-development efforts relatively late in the weapon system acquisition cycle, as well as the extensive reliance on time-consuming and labor-intensive manual methods which remain highly subjective and are not standardized, the USAF has established the Cockpit Automation Technology (CAT) development program. Attention is presently given to the CAT program's technical objectives and

industry definition approaches. In addition, the mission analysis demonstration software developed by each of the three industry teams involved is described and evaluated for its potential contribution to the crew system design process. O.C.

**A88-34147****EVALUATION OF A PILOT'S LINE-OF-SIGHT USING ULTRASONIC MEASUREMENTS AND A HELMET MOUNTED DISPLAY**

WALTER E. AXT (AEG, Wedel, Federal Republic of Germany) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 921-927.

Several current problems in aerial warfare include the use of the pilot's sight under the aspects of night-vision capability as well as of locking aircraft systems on targets with no delay. The desire for a trouble-free visually coupled system led to the development of the combination of line-of-sight locator and helmet mounted display. The solution is based on the ranging of the three angles of head movement in azimuth, elevation and roll by measuring the transmission times of ultrasonic signals between transmitters mounted on the pilot's helmet and receivers on the cockpit structure, whereas the visual information is displayed in front of the pilot's eye by an optical system which receives the image from a remote CRT display. I.E.

**A88-34148#****DUAL PROPRIOCEPTION OBTAINED THROUGH ASSISTIVE CONTROLLERS**

D. W. REPPERGER (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 928-934. refs

A computer-aided assistive controller is used to investigate how parallel processing of visual information with displacement stick feedback and force stick feedback can improve tracking performance. The assistive aid used here produces a force on the human hand (through a lateral stick controller) which modulates the arm-stick mechanical impedance. The key to dual proprioception is to make the transfer function between the eye and hand to match the mechanical impedance of the stick as well as to match the transfer function modeling the displacement characteristics of the stick position output to human force input. Data are reported for four subjects participating in an experiment with different matches and mismatches between the three transfer functions. I.E.

**A88-34149#****DECISION AIDS: DISASTERS WAITING TO HAPPEN?**

ERHARD O. EIMER (Wittenberg University, Springfield, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 936-943. refs

The author explores the effects of a decision-aiding device (DAD) on performance in a command, control, and communication system task requiring judgement about uncertain events. Subject rating data were transformed into measures of task performance, of reliance on a DAD, and of observer efficiency. Two issues are addressed: how much is system performance degraded by a failing decision aid, and what factors affect this degradation? I.E.

**A88-34150****A RESEARCH AGENDA FOR THE SOCIAL PSYCHOLOGY OF INTELLIGENT MACHINES**

A. RODNEY WELLES (Miami, University, Coral Gables, FL) and MICHAEL D. MCNEESE (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics

Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 944-950. refs

The interaction of humans with intelligent machines may be seen as a new form of dynamic social interaction. The social psychology of intelligent machines represents a proposed interdisciplinary approach to understanding the impact of artificially intelligent systems on human cognitive, emotional and behavioral functioning. A variety of observations are cited from the disciplines of social, cognitive, and clinical psychology, communications and human factors engineering. A call is made for the systematic study of these and related phenomenon to increase the understanding of human-machine interface. I.E.

**A88-34151****AUGMENTING THE PILOT/VEHICLE INTERFACE THROUGH CAPABILITY ASSESSMENT**

KATHERINE PALKO and RANDY BOYS (Texas Instruments, Inc., Defense Systems and Electronics Group, Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 956-964. refs

The application of artificial intelligence and human factors engineering to future combat aircraft will create opportunities for improving the pilot/vehicle interface. One potential application is to assess and predict fighter pilot capabilities in real-time in order to create a tailored flow of information and procedures; one that closely matches the pilot's momentary capabilities. The anticipated outcome is an enhancement of pilot situational awareness, performance, and mission success. The authors discuss the potential contributions to these goals of a robust pilot capability assessment function within an intelligent pilot/vehicle interface. I.E.

**A88-34152****METHODOLOGY FOR THE DEVELOPMENT OF BIOCYBERNETIC AIRCREW PERFORMANCE MONITORING TECHNIQUES**

CLARK A. SHINGLEDECKER and MARK S. CRABTREE (NTI, Inc., Dayton, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 966-971. refs

A theoretical and empirical approach designed to identify and validate nonintrusive methods for monitoring the performance capabilities of aircrews and other system operators is described. The purpose of such monitoring would be to anticipate degraded human performance caused by operational stressors, fatigue or task overload, and to initiate corrective actions. A theoretical framework for the selection of potential monitoring parameters is described, as well as a correlational methodology for validating their capabilities to predict performance variation. The results of a preliminary demonstration of the methodology are also presented. I.E.

**A88-34153#****A STUDY OF DOT MATRIX DISPLAY RECOGNITION USING CRITICAL FEATURE ENHANCEMENT**

JOHN P. ZENYUH, KIM M. MAZUR, JOHN M. REISING (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and JOSEPH C. HICKOX (U.S. Air Force Academy, Colorado Springs, CO) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 976-978. refs

Recognition performance for both pictorial and alphanumeric dot matrix displays, with and without enhanced critical features, was evaluated. Pictorial symbol enhancement was accomplished by increasing the critical feature size by 60-70 percent, while alphanumeric legends were enhanced by showing consonants as upper case letters and vowels as lower case. The subject's task was to identify the location of a particular target symbol or legends

from a bank of four displayed simultaneously for a duration of 200 ms. Results are presented and indicate that text presented in the enhanced manner interfered with the subject's ability to process the symbol. No significant main effects were found for either display type or feature. I.E.

#### A88-34155

##### THE HYDRO- AND RESULTING BIO-DYNAMICS OF +GZ INDUCED LOSSES OF CONSCIOUSNESS AND ITS HISTORY

E. H. WOOD, E. H. LAMBERT, and C. F. CODE (Mayo Foundation, Rochester, MN) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 988-995. refs (Contract N66001-87-C-0079)

Positive Gz induced loss of consciousness (GLOC) can be defined as a loss of cognitive brain function due to acute cerebral ischemic anoxia caused by exposure to an increased gravitational-inertial force environment sustained for longer than the 3-7 second ischemic anoxic latent period between acute stoppage or near stoppage of cerebral blood flow and loss of cognitive brain function. The historical aspects of this review are restricted to findings which reveal the cause of GLOC and thus provide a firm physiologic basis for consideration of means for prevention. I.E.

#### A88-34157#

##### A COMPARISON OF THE CENTRIFUGE AND FLIGHT TESTS OF NEW CONCEPT ANTI-G VALVES

CRISPOLD A. CAMPELLI, JOHN W. FRAZIER, MICHAEL T. JACKSON (USAF, Wright-Patterson AFB, OH), and LARRY J. MEEKER (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1006-1010. refs

Advances in aircraft propulsion systems and airframes have increased the capability of current fighter aircraft to perform sustained high-G maneuvers. These developments have led to a need to provide similar improvements to the life-support system to protect the pilot against high G forces. The authors describe the testing of four novel-concept anti-G valves: the Alar high-flow, ready-pressure; the Garrett servo; the Moog servo; and the bang-bang solenoid valve. Results presented include unmanned test data from the centrifuge experiments and pilots' ratings during flight tests in an F-16B. I.E.

#### A88-34158

##### INCREASED ACCELERATION TOLERANCE USING A PULSATING ANTI-G SUIT

D. JARON, T. W. MOORE, B. R. S. REDDY, F. KEPICS (Drexel University, Philadelphia, PA), and L. HREBIEN (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1011-1013. refs (Contract N0014-85-K-0566)

A novel antigravity suit and an associated control system were designed and tested in a dynamic flight simulator. The suit design resulted from computer simulations that showed this concept likely to be superior to the steady pressure suit. A standard anti-G suit was modified to permit separate inflation/deflation of each bladder. A computer constantly monitored the R-R interval and synchronized events to the R-wave of EKG. Timing of actuation of the valves was controlled by the computer while the pressure levels were determined by the level of the G stress and the desired pressure excursions. Modes of suit operation tested included systolic and diastolic phasing of the inflation pressure phase and simultaneous or sequential inflation of the bladders. Results indicate that significant additional G protection may be achieved using the concept of a pulsating suit. I.E.

#### A88-34159

##### MATRIX IMPLEMENTATION OF A CARDIOVASCULAR MODEL UNDER +GZ STRESS FOR THE ANALYSIS AND DESIGN OF AN ANTI-G SUIT CONTROLLER

SHERIF A. AZIZ and KULDIP S. RATTAN (Wright State University, Dayton, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1014-1021. refs (Contract F49620-85-C-0013)

Acceleration forces in the +Gz direction (head to foot) causes pooling of the blood in the abdomen and legs and reduces blood flow to the heart and upper body. To study these phenomena, a computer simulation of the cardiovascular system under +Gz stress was implemented using System—Build of the computer-aided design package MATRIXx. An anti-G suit was added to the model to study the compensatory effects of existing anti-G suit valves. Results for high flow and bang-bang servo valves were obtained and a closed-loop strategy to improve the design of the existing anti-G suit is proposed. I.E.

#### A88-34163#

##### INTEGRATION OF WEAPON SYSTEM TRAINER (WST) FOR LARGE BODY AIRCRAFT INTO COMBAT CREW TRAINING

CONRAD G. BILLS (USAF, Aeronautical System Div., Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1054-1059. refs

Weapon system trainer (WST) technology constitutes a sophisticated simulation system developed for large body aircraft (e.g., B-52, KC-135, C-130). Training effectiveness studies have been conducted for the WST; these have recommended that this technology be employed as a proficiency-base rather than proficiency-enhancement methodology. Front-loading WST training for any given task, and demonstrating proficiency before training in the aircraft, yields a substantial reduction in the number of attempts required to yield criterion proficiency aboard the aircraft. I.E.

#### A88-34566

##### CREW ACTIVITIES

WUBBO J. OCKELS (ESA, Columbus Crew Activities Working Group, Noordwijk, Netherlands) (CNR and Aeritalia S.p.A., Columbus Symposium, 3rd, Capri, Italy, June 30-July 2, 1987) Space Technology - Industrial and Commercial Applications (ISSN 0277-4488), vol. 8, no. 1-2, 1988, p. 175-177.

The role of the crew members in planned Columbus science experiments is discussed from the perspective of an astronaut, arguing that the value of a manned presence in increased experimental flexibility and problem solving far outweighs the disadvantages and higher costs of manned missions. Topics addressed include ESTEC efforts to optimize the Columbus man-machine interfaces, recent studies by the Columbus Crew Activities Working Group, lessons learned in the Spacelab program, the need for larger-volume more easily accessible experiment packages to facilitate crew intervention, and the scheduling of a typical day in orbit. It is suggested that having the two crew members responsible for a Station laboratory module work together for 12 h and then leave the module unattended for 12 h may often be more efficient than having them work alternating shifts. T.K.

#### A88-34569

##### CREW WORK STATION TEST-BED

J. HOWIESON, W. VAN LEEUWEN, and W. J. OCKELS (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) (CNR and Aeritalia S.p.A., Columbus Symposium, 3rd, Capri, Italy, June 30-July 2, 1987) Space Technology - Industrial and Commercial Applications (ISSN 0277-4488), vol. 8, no. 1-2, 1988, p. 191-194.

The quality of the man machine combination in a manned space system depends on how safely and reliably the astronaut

can execute responsibilities and effectively perform the work. The Crew Work Station (CWS) Test-Bed in ESTEC has been established as a reference of state-of-the-art man machine interface technology so that ESA and industry can acquire the expertise necessary for Columbus. It is an experimental laboratory for early validation of concepts and technology, and to provide facilities for the Columbus utilization community to influence Columbus design. An initial program of investigations was carried out during 1987 into a wide range of CWS aspects. Author

## A88-35111

### CONCEPTS AND ISSUES FOR A SPACE TELEROBOT

JIM CHAPEL (Martin Marietta Corp., Denver, CO) IN: Aerospace century XXI: Space flight technologies; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986. San Diego, CA, Univelt, Inc., 1987, p. 971-984. refs

(AAS PAPER 86-302)

The requirement for a dexterous space teleoperator for Space Station activities are presently addressed by a dexterous space telerobotic servicer concept which will be equivalent in capabilities to an astronaut on EVA duties. The potential benefits derivable from the incorporation of force feedback, compliant teleoperation, predictive displays, computer vision, and supervisory control are discussed. Attention is drawn to the substantial amount of off-the-shelf hardware that is directly applicable to the present telerobotic servicer concept. O.C.

**A88-35132\*** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.

### A 'BREADBOARD' BIOMASS PRODUCTION CHAMBER FOR CELSS

RALPH P. PRINCE, WILLIAM M. KNOTT, III, SUZANNE E. HILDING, and TOMMY L. MACK (NASA, Kennedy Space Center, Cocoa Beach, FL) IN: Aerospace century XXI: Space sciences, applications, and commercial developments; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986. San Diego, CA, Univelt, Inc., 1987, p. 1291-1303. refs

(AAS PAPER 86-338)

The Breadboard Project of the Controlled Ecological Life Support System (CELSS) Program is the first attempt by NASA to integrate the primary components of a bioregenerative life support system into a functioning system. The central component of this project is a Biomass Production Chamber (BPC). The BPC is under construction, and when finished will be sealed for the study of the flux of gases, liquids, and solids through the production module of a CELSS. Features of the CELSS breadboard facility will be covered as will design requirements for the BPC. Cultural practices developed for wheat for the BPC will be discussed. Author

## A88-35133

### THE ROLE OF SPACE STATION LIFE SCIENCES

#### EXPERIMENTS IN THE DEVELOPMENT OF A CELSS

NANCY SEARBY, PAUL DOLKAS, and S. SCHWARTZKOPF (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) IN: Aerospace century XXI: Space sciences, applications, and commercial developments; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986. San Diego, CA, Univelt, Inc., 1987, p. 1313-1318.

(AAS PAPER 86-340)

A plan for integrating supporting research for NASA's Controlled Ecological Life Support System (CELSS) with the development and operation of the Space Station laboratory equipment is outlined. Functional descriptions are given for the CELSS plant holding facility, animal metabolic measuring system, waste processing system, recycling loops (between the heterotrophic and autotrophic components of the system), and variable gravity research centrifuge. Applicable experiments are discussed, and the use of existing technology for the development of the CELSS is considered. R.R.

## A88-35374

### PREDICTING MAN-MACHINE SYSTEM PERFORMANCE IN PREDESIGN

CHARLES D. HOLLEY and ROGER E. PARKS (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987. Alexandria, VA, American Helicopter Society, 1987, 13 p. refs

A fundamental problem in the procurement of military weapons systems is the capability for the procurement system to field the material in time to counter the mission shortcoming. This is particularly difficult in the real-life realm of a constantly changing threat. Valid system (that is, crew and equipment) performance predictions, particularly during the early stages of design, may be a key to solving this problem. Advances in digital simulation and artificial intelligence techniques have made such predictions possible. In this paper, classical digital simulation approaches and models are reviewed and a particular (hybrid) model is discussed in depth. Predictive validation data are presented to illustrate that this model can achieve the system design goals during predesign. Author

## A88-35376

### ADVANCED HELICOPTER COCKPIT INFORMATION MANAGEMENT

STEVE MARTZ (Boeing Military Airplane Co., Wichita, KS), CATHY LEININGER, and JIM DACUS (Boeing Computer Services Co., Wichita, KS) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987. Alexandria, VA, American Helicopter Society, 1987, 8 p. refs

The growing complexity of advanced helicopter systems has increased pilot workload. Human-machine interface characteristics and thus mission performance are adversely affected by less than optimal integration of information from complex helicopter systems. Expert system technology offers great potential for alleviating the pilot workload associated with making routine as well as exceptional decisions as to information to be displayed. The numerous possible combinations of display information can be intelligently filtered by an expert system dedicated to cockpit information management. An additional benefit is the flexibility obtained through an expert system implementation of a cockpit information manager. This paper describes a prototype expert system developed to demonstrate these benefits. Author

## A88-35401

### HUMAN FACTORS SOCIETY, ANNUAL MEETING, 31ST, NEW YORK, NY, OCT. 19-23, 1987, PROCEEDINGS. VOLUMES 1 & 2

Meeting organized by the Human Factors Society; Sponsored by the American Telephone and Telegraph Co., Bell Communications Research, Inc., IBM, et al. Santa Monica, CA, Human Factors Society, 1987, p. Vol. 1, 753 p.; vol. 2, 728 p. For individual items see A88-35402 to A88-35498.

Topics discussed include macroergonomics, automation safety, general techniques of test and evaluation, issues in training design, performance issues in displays and control, biomechanical methods, the criterion task set, simulator sickness, capacity limitations in human information processing, and the use of physiological measures in aviation-related research. Attention is also given to ergonomic design, hands and gloves, database access and format, environmental design, visual and auditory detection performance, development of test methods, and tools and techniques for interface design. B.J.

## A88-35402

### NEW TECHNOLOGY, HUMAN PERFORMANCE AND TRANSPORTATION SYSTEM SAFETY

JOHN K. LAUBER (National Transportation Safety Board, Washington, DC) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 15-20. refs

An effort is made to elucidate a 'great challenge' facing the



human factors profession: how to design, build, and operate systems so that accidents caused by human error are minimized. A number of examples of transportation accidents or near-accidents are cited to illustrate the problems involved. The need to develop appropriate human factors design guidelines or other methodology which will adequately identify design shortcomings is emphasized.

B.J.

**A88-35403**  
**OPERATOR MODELING - CONCEPTUAL AND**  
**METHODOLOGICAL DISTINCTIONS**

PATRICIA M. JONES and CHRISTINE M. MITCHELL (Georgia Institute of Technology, Atlanta) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 31-35. refs

Different models of the human operator are reviewed, and then characterized in terms of four conceptual dimensions: purpose, structure, content, and specificity. The focus of the study is on the human operator in the context of a manual or supervisory control system, the ultimate goal being to characterize and extend the operator function model of Mitchell (1987) and Mitchell and Miller (1986). Methodological issues in operator modeling are also considered.

B.J.

**A88-35404**  
**EMPIRICAL USER MODELING - COMMAND USAGE**  
**ANALYSES FOR DERIVING MODELS OF USERS**

MATTHEW P. ANDERSON, JAMES E. McDONALD, and ROGER W. SCHVANEVELDT (New Mexico State University, Las Cruces) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 41-45. refs

Models of users' procedural knowledge were derived from the records of command usage obtained from nine experienced users of the Unix operating system. Pairwise transitions between user command entries were analyzed for the purpose of identifying salient command patterns associated with task-based user behaviors. Structural models of command usage patterns were obtained from Pathfinder network scaling of Unix command events. The network representation of command patterns was evaluated as a method for abstracting users' procedural knowledge. These network scaling solutions revealed patterns that were common both within and across users' command usage.

Author

**A88-35405**  
**DESIGNING AIRLINE PASSENGER SAFETY CARDS**

JOHN K. SCHMIDT (Maryland, University, College Park) and KRAGG P. KYSOR (Towson State University, MD) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 51-55. refs

The field of human factors endeavors to optimize and standardize interfaces in an attempt to achieve the best fit possible, to include the design of instructional material. The authors have observed that airline passenger safety cards vary greatly in layout, construction, etc. and could benefit from guidelines presented in the pertinent literature. The present effort examined both user preference as well as card effectiveness. It was found that cards which implement recommended techniques are more preferred and effective than those that do not.

Author

**A88-35413**  
**EYE AND HEAD DISPLACEMENT TO TARGETS FIXATED IN**  
**THE VERTICAL AND HORIZONTAL PLANES**

WILLIAM P. JANSON (Systems Research Laboratories, Inc., Dayton, OH), DAVID L. QUAM (MacAulay-Brown, Inc., Dayton, OH), and GLORIA L. CALHOUN (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 243-247. refs  
 (Contract F33615-85-C-0541; F33615-82-C-0513)

While the nature of eye and head displacements to target acquisitions in the horizontal plane have been frequently studied, such investigations in the vertical plane are somewhat scarce. In the experiment reported herein the final displacements of the head, eye, and gaze were examined for target acquisitions in the vertical and horizontal planes. The subjects' task was to fixate on a central target until receiving a verbal command to fixate on one of four peripheral targets. The analysis of the mean head, eye, and gaze displacement data to the target locations suggests similar trends across the vertical and horizontal planes.

Author

**A88-35416**  
**RAISING CONTROL/DISPLAY EFFICIENCY WITH RAPID**  
**COMMUNICATION DISPLAY TECHNOLOGY**

ETHEL MATIN (Long Island University, Greenvale, NY), KENNETH R. BOFF (USAF, Harry G. Armstrong Medical Research Laboratories, Wright-Patterson AFB, OH), and REBECCA DONOVAN (Systems Research Laboratories, Inc., Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 258-262. refs  
 (Contract F33615-85-C-0541)

Basic research related to the development of a new visual display technology is described. Essentially, this technology enables the serial presentation of independent frames of visual information via a single display window. An experiment compared the serial display with a conventional display consisting of three spatially separated windows which subjects accessed by making saccadic eye movements. Another experiment measured the duration threshold in a serial display as a function of the number of sequentially presented frames, which varied between one and twelve. The results showed an approximately linear increase in threshold with number of frames for both tasks.

Author

**A88-35418**  
**ADVANCED HUMAN FACTORS ENGINEERING TOOL**  
**TECHNOLOGIES**

KATHRYN E. PERMENTER, STEPHEN A. FLEGER, and THOMAS B. MALONE (Carlow Associates, Inc., Fairfax, VA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 345-349.

The paper presents results of a study to identify advanced human factors engineering (HFE) tool technologies that are in use, or projected for use, by HFE practitioners. The study was intended to support the U.S. Army's MANPRINT program. Practitioners reported that the greatest need within the HF community was for the development of automated task analysis programs, HF database compendia, workload prediction tools, and expert systems. The majority of practitioners surveyed expressed a desire to see more advanced tools developed for the microcomputer.

B.J.

**A88-35419**  
**HUMAN FACTORS ENGINEERING PLANNING AID**

STEPHEN C. MERRIMAN (McDonnell Aircraft Co., Saint Louis, MO) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 350-352. refs

This paper describes the application of affordable program management software to the task of planning human factors programs conducted in support of complex system developments. A model of the military system acquisition process was developed and a model human factors engineering program was overlaid upon it. Interdependencies were created between the models so that changes made in the acquisition schedule would cause the human factors program to be automatically tailored. This approach has potential to reduce planning time and increase the quality of human factors plans.

Author

**A88-35420**  
**STALL - A SIMPLE MODEL FOR WORKLOAD ANALYSIS IN**  
**EARLY SYSTEM DEVELOPMENT**

GERALD P. CHUBB, NOREEN STODOLSKY, WARREN D. FLEMING, and JOHN A. HASSOUN (SoftTech, Inc., Fairborn, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 363-367. Research sponsored by the Northrop Corp. refs

The Saturation of Tactical Aviator Load Limits (STALL) is defined as the interaction of asymptotically high and low load limits. STALL provides an analysis of pilot message handling in supervisory control of automated systems based on estimates of load arrival rates, and a mean value analysis of the effective service rate for four cases of a response service network; a fifth case treats the representation of target attack and is used in conjunction with one of the other four cases to portray forced time sharing in a dual-task situation. Preliminary application and validation efforts have demonstrated the potential utility of STALL and its robustness with respect to selected violations of the underlying model assumptions. B.J.

#### A88-35421

##### ANALYTIC TECHNIQUES FOR THE ASSESSMENT OF OPERATOR WORKLOAD

SUSAN G. HILL, ROBERT LYSAGHT, A. O. DICK (Analytics, Inc., Willow Grove, PA), BRIAN D. PLAMONDON (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT), WALTER W. WIERWILLE (Virginia Polytechnic Institute and State University, Blacksburg) et al. IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 368-371. refs

(Contract MDA903-86-C-0384)

Analytic techniques for the assessment of operator workload are predictive techniques that can be applied early in system design before operator-in-the-loop studies. Five categories of analytic techniques are described: (1) comparability analysis, (2) mathematical models, (3) expert opinion, (4) task analytic methods, and (5) simulation models. Examples are given for each category. B.J.

#### A88-35429

##### VOICE AND MANUAL CONTROL IN DUAL TASK SITUATIONS

LERAY L. LEBER, CHRISTOPHER BAKKE, MICHAEL SULEK (U.S. Air Force Academy, Colorado Springs, CO), CHRISTOPHER D. WICKENS (Illinois, University, Savoy), and WILLIAM MARSHAK (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 419-423. refs

The objective of this research was to replicate and extend an investigation of Voice and Manual Control in Dual Task Situations previously performed by Wickens et al. (1985). This study incorporated both the previous within-subject design with a much larger sample size and a novel between-subject paradigm. The repeated measures investigation minimizing asymmetric transfer between response conditions revealed significantly better performance when a verbal Sternberg task was voice controlled in combination with a manually controlled spatial tracking task. The between-subject study likewise supported this finding. The previous 1985 study's findings favoring hemispherically compatible left-handed tracking were not supported in this investigation. Author

#### A88-35433

##### AN EVALUATION OF DISPLAY/CONTROL GAIN

LYNN Y. ARNAUT (Hewlett-Packard Co., Sunnyvale, CA) and JOEL S. GREENSTEIN (Clemson University, SC) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 437-441. Navy-supported research. refs

Two studies were conducted to evaluate the adequacy of identifying the optimum display/control gain for an interface as a method of control-display interface optimization. The first study

examined the effects of changes in both the maximum control input and the display width on target acquisition performance with a touch tablet and a trackball. The second study evaluated the effects of changes in the display amplitude, the display target width, and the control amplitude. Results from both studies indicate that gain is an insufficient specification for performance. In addition, the inadequacy of Fitts' Law in this context is discussed. Author

#### A88-35436

##### VISUAL DISPLAY FACTORS CONTRIBUTING TO SIMULATOR SICKNESS

LAWRENCE J. HETTINGER, MARGARET D. NOLAN, ROBERT S. KENNEDY, KEVIN S. BERBAUM, KEVIN P. SCHNITZIUS (Essex Corp., Orlando, FL) et al. IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 497-501. refs

(Contract N61339-85-D-0026)

The history of research on visually-induced illusory self motion, orvection, has demonstrated that in many instances observers have experienced disturbances similar to those of motion sickness. Visual displays in flight simulators may also produce the experience ofvection, and illusions of self motion are likely to become more common with the increased use of wide field-of-view presentations of realistic imagery. Many of the disturbances observed in laboratory studies ofvection have also been found in simulators, and are likely to become more common. This paper presents a background to the study of visual-vestibular disturbances associated with illusory self motion in flight simulators, and an overview of current experimental efforts aimed at identifying the causal factors. Author

#### A88-35440

##### SITUATIONAL AWARENESS IN MAP DISPLAYS

WILLIAM P. MARSHAK, GILBERT KUPERMAN, DENISE WILSON (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH), and ERIC G. RAMSEY (Systems Research Laboratories, Inc., Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 533-535. USAF-supported research. refs

The effectiveness of ego-centered (moving map) and earth-centered (moving plane) displays was studied with subjects monitoring an animated aircraft situational awareness display. Other independent variables were subject experience (aircrew vs non-aircrew) and path complexity (straight vs turning). Periodically, the display blanked and probe questions were asked concerning the relationship of the aircraft to the simulated world. Questions included judgments about angles, distances, time and terrain. Simple paths elicited a 28 percent lower error rate than did complex paths. Moving map displays had a 32 percent lower error rate than moving plane displays. No other significant effects were observed. Subjective ratings by subjects after the experiment revealed unanimous preference for the moving plane display and that the moving plane condition was believed to be easier. This contradiction indicates subjective data is limited in determining display effectiveness. Author

#### A88-35442

##### A COMPARISON OF SHAPE/OBJECT DISPLAYS, QUASI SHAPE DISPLAYS, AND CONVENTIONAL UNIVARIATE INDICATORS - INTEGRATION BENEFITS OR THE 'NEARER TO THEE' EFFECT?

DENNIS B. BERINGER and STEVEN E. CHRISMAN (New Mexico State University, Las Cruces) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 543-547. refs

The factors responsible for the superior performance of polar displays of continuous system-control information are investigated experimentally. The ability of subjects to perform multiple aircraft-pilot tasks of varying difficulty with information supplied by multiple univariate (needle) indicators, polar histograms, and polar

polygons in different physical layouts is monitored, and the results are presented in graphs. Subject performance is found to be superior with polar displays in all cases, regardless of display proximity. It is inferred that the shape/object displays permit the subject to integrate display information to a greater degree. T.K.

**A88-35443\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**COMPARISON OF WORKLOAD MEASURES ON COMPUTER-GENERATED PRIMARY FLIGHT DISPLAYS**

MARK NATAUPSKY and TERENCE S. ABBOTT (NASA, Langley Research Center, Hampton, VA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 1. Santa Monica, CA, Human Factors Society, 1987, p. 548-552. refs

Four Air Force pilots were used as subjects to assess a battery of subjective and physiological workload measures in a flight simulation environment in which two computer-generated primary flight display configurations were evaluated. A high- and low-workload task was created by manipulating flight path complexity. Both SWAT and the NASA-TLX were shown to be effective in differentiating the high and low workload path conditions. Physiological measures were inconclusive. A battery of workload measures continues to be necessary for an understanding of the data. Based on workload, opinion, and performance data, it is fruitful to pursue research with a primary flight display and a horizontal situation display integrated into a single display. Author

**A88-35452**

**HANDGRIP STRENGTH WITH THE BARE HAND AND IN THE NASA SPACESUIT GLOVE**

J. RICHARD ROESCH (Human Factors Applications, Inc., Panama City, FL) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 786-790. refs

This study examined handgrip strength with the bare and spacesuit-gloved hand, in three hand- and two elbow positions. Sixteen subjects from the suited-subject pool at NASA/Johnson Space Center gripped a hand dynamometer encased in a vacuum chamber designed to simulate the pressure differential of the spacesuit in space. With the bare hand (at one atmosphere), there was an effect for hand position and a hand-position x elbow-position interaction. With the spacesuit-gloved hand, there was only an effect for hand position. Two different pressure differentials were used; the glove at 0.5 psid was responsible for a 35 percent grip decrement (when compared to bare handgrip); the glove at 4.3 psid (normal operating pressure) was responsible for a 42 percent grip decrement. Bare and gloved-handgrips were positively correlated with hand size, body weight, height, and forearm circumference. Post hoc, subjects were grouped by hand size; the four subjects in the XL hand-size group lost an average of 17 percent in grip in the glove at 4.3 psid (when compared to the glove at 0.5 psid); the L group lost 12 percent; the M group lost 9 percent; and the S hand-size group lost less than 1 percent. Author

**A88-35453\*** Grumman Aerospace Corp., Bethpage, N.Y.

**TELEROBOTIC CONTROL OF A DEXTROUS MANIPULATOR USING MASTER AND SIX-DOF HAND-CONTROLLERS FOR SPACE ASSEMBLY AND SERVICING TASKS**

JOHN M. O'HARA (Grumman Corp., Grumman Space Systems Div., Bethpage, New York) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 791-795. refs  
(Contract NAS9-17229)

Two studies were conducted evaluating methods of controlling a telerobot; bilateral force reflecting master controllers and proportional rate six degrees of freedom (DOF) hand controllers. The first study compared the controllers on performance of single manipulator arm tasks, a peg-in-the-hole task, and simulated satellite orbital replacement unit changeout. The second study, a

Space Station truss assembly task, required simultaneous operation of both manipulator arms (all 12 DOFs) and complex multiaxis slave arm movements. Task times were significantly longer and fewer errors were committed with the hand controllers. The hand controllers were also rated significantly higher in cognitive and manual control workload on the two-arm task. The master controllers were rated significantly higher in physical workload. There were no significant differences in ratings of manipulator control quality. Author

**A88-35454**

**USE OF INFRARED TELEMETRY AS PART OF A NONINTRUSIVE INFLIGHT DATA COLLECTION SYSTEM TO COLLECT HUMAN FACTORS DATA**

ANGELO J. MICOCCHI (Lockheed Engineering and Management Services Co., Inc., Houston, TX) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 796-799. refs

The paper presents the methodology and rationale for the development and use of a nonintrusive in-flight data collection system (NIDCS) for the collection of human factor data during a space mission. The NIDCS includes methods for the collection of three types of data: behavioral, physiological, and biomechanical. These will be collected using a videotape of crew members' activities, bioelectric signal measurements, and the measurements of kinematics and kinetics, respectively. In this paper, emphasis is placed on the measurements of physiological activity, as determined by changes in bioelectric potentials, using an IR telemetry system for nonintrusive transmission of physiological signals. The system contains both a transmitter and a receiver unit with an end-to-end response of 6 kHz. The results of tests performed on a 'preboard' model of this system are described. I.S.

**A88-35455**

**CREW-INDUCED LOAD MEASUREMENT FOR SPACE OPERATIONS**

RUTHAN LEWIS (Lockheed Engineering and Management Services Co., Inc., Houston, TX) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 800-802.

A method has been developed to simulate and measure crew-induced and reactive loads for a variety of intravehicular and extravehicular tasks. The method employs the use of a dynamometer attached to an adjustable support, and a three-axis force/torque platform. Translational and rotational hand/arm forces and torques, and foot reaction forces and torques may be measured simultaneously. The apparatus has been designed for on-orbit and ground-based usage. Beyond explanation of the instrumentation, the presentation will address data on forces effected by crew members, and the applications, implications, and integration of the information with regards to planning space operations and design of crew-interfaced items. Author

**A88-35456\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

**HABITABILITY IN LONG-TERM SPACE MISSIONS**

FRANCES E. MOUNT (NASA, Johnson Space Center, Houston, TX) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 803-805.

The research (both in progress and completed) conducted for the U.S. Space Station in relation to the crew habitability and crew productivity is discussed. Methods and tasks designed to increase the data base of the man/system information are described. The particular research areas discussed in this paper include human productivity, on-orbit maintenance, viewing requirements, fastener types, and crew quarters. This information (along with data obtained on human interaction with command/control work station, anthropometric factors, crew equipment, galley/wardroom, restraint systems, etc) will be

integrated into the common data base for the purpose of assisting the design of the Space Station and other future manned space missions. I.S.

**A88-35457\*** Lockheed Engineering and Management Services Co., Inc., Houston, Tex.

**HUMAN-TELEROBOT INTERACTIONS - INFORMATION, CONTROL, AND MENTAL MODELS**

RANDY L. SMITH and DOUGLAS J. GILLAN (Lockheed Engineering and Management Services Co., Inc., Houston, TX) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 806-810. refs (Contract NAS9-17900)

A part of the NASA's Space Station will be a teleoperated robot (teleroobot) with arms for grasping and manipulation, feet for holding onto objects, and television cameras for visual feedback. The objective of the work described in this paper is to develop the requirements and specifications for the user-teleroobot interface and to determine through research and testing that the interface results in efficient system operation. The focus of the development of the user-teleroobot interface is on the information required by the user, the user inputs, and the design of the control workstation. Closely related to both the information required by the user and the user's control of the teleroobot is the user's mental model of the relationship between the control inputs and the teleroobot's actions. Author

**A88-35462**

**A METHOD FOR MEASURING THE EFFECT OF GRIP SURFACE ON TORQUE PRODUCTION DURING HAND/ARM ROTATION**

RUTHAN LEWIS (Lockheed Engineering and Management Services Co., Inc., Houston, TX) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 898-900.

During EVA operations, where time is extremely limited, a grip interface that would cause regripping of a surface or repositioning of the hand to assume a more effective or more comfortable grip must be avoided. This paper presents a method for measuring the effect of grip surface on torque production during rotation by the space-gloved hand during a simulated on-orbit construction operation. An isokinetic dynamometer was used as the measuring device to distinguish human interface differences between various connector surface types; the device was used to test single-joint-effected motions, registering torque and the position of the torque within the range of motion at the joint as a function of applied load. It is shown that this method can be used to simulate the complex resultant of multiple-joint motion. Controls can be instituted according to the application, so that comparisons of static and dynamic measures can be made between specified conditions. I.S.

**A88-35463**

**THE EFFECTS OF DIFFERENT DATA BASE FORMATS ON INFORMATION RETRIEVAL**

DEBORAH BOEHM-DAVIS, ROBERT HOLT, MATTHEW KOLL, GLORIA YASTROP, and ROBERT PETERS (George Mason University, Fairfax, VA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 983-986. (Contract N00014-85-K-0243)

This research examined the effects of three different data-base formats on the information retrieval performance of users. Spatial, tabular, and verbal forms of two data-base domains (airline and thesaurus) were constructed along with questions that required users to search through the data base to determine the correct response. Three types of questions were designed: spatial, tabular, and verbal. The data indicate that users are faster and more accurate in responding to the questions when the format of the information in the data base matches the type of information

needed to answer the question. While the importance of matching data base format to query type may seem to be obvious, it would appear that the designers of most current data base systems have not taken this into account. Author

**A88-35470**

**A DESKTOP EXPERT SYSTEM AS A HUMAN FACTORS WORK AID**

CRAIG S. HARTLEY and JOHN R. RICE (Martin Marietta Corp., Denver, CO) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1087-1090.

A small desktop expert system designed as a work aid for human factor engineers was developed using a commercially available expert system development tool, NEXPERT. The candidate problem area selected was based on four criteria: (1) a limited-size problem domain that could be covered comprehensively by a relatively small knowledge base, (2) the problem domain that had to be potentially useful to a video display terminal (VDT), (3) the information that was available in human factor guidelines, published reports, and journal articles, and (4) the problem that would use NEXPERT features maximally. The topic area selected was 'video display screen color'. The goal was to produce a job performance aid which could be used by VDT screen designers for the selection of appropriate colors for screen features. It was demonstrated that such an expert system could provide useful human factor expertise to system designers, making it possible to design software with company-wide consistency and to simplify software requirements documentation. I.S.

**A88-35471**

**MICROCOMPUTER HUMAN OPERATOR SIMULATOR (HOS-IV)**

REGINA M. HARRIS, HELENE P. IAVECCHIA, LORNA V. ROSS, and STEVEN C. SHAFFER (Analytics, Inc., Willow Grove, PA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1179-1183. refs (Contract F33615-86-C-0019)

This paper describes the 4th-generation model of the Human Operator Simulator (HOS-IV) as implemented on an IBM PC AT microcomputer. HOS is a general purpose simulation tool for modeling the cognitive, perceptual, and motor activities of an operator who is performing a set of tasks during the course of a mission. HOS provides the capability to model the hardware system and the external environment which impact operator workload and system performance. Discussed are the new features of HOS-IV including the user-oriented interface, knowledge representation scheme, and enhanced modeling capabilities. Author

**A88-35472**

**A DETECTION THEORY METHOD FOR THE ANALYSIS OF VISUAL AND AUDITORY DISPLAYS**

ROBERT D. SORKIN (Purdue University, West Lafayette, IN), DONALD E. ROBINSON, and BRUCE G. BERG (Indiana University, Bloomington) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1184-1188. USAF-supported research. refs

A signal detection method for evaluating different display codes and formats is described. The method allows one to determine how an observer aggregates information from multiple element displays. The method can be used to assess the relative importance of specific spatial or sequential elements of the display. The efficacy of different formats and arrangements thus can be compared. The paper describes the theoretical basis for the method and briefly summarizes data from several types of visual and auditory displays. Author

**A88-35475**

**SIGNAL DETECTION PERFORMANCE AS A FUNCTION OF FOURIER DESCRIPTION OF SYMBOLS**

WILLIAM P. MARSHAK (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) and

JOHN C. OSARCZUK (USAF, Ellsworth AFB, SD) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1198-1201. refs

This paper reports the Fourier analysis of stimuli, using data of the Marshak and Osarczuk (1984) on the signal detection performance. The latter authors have used target and background stimuli designed to systematically differ in spatial frequency and orientation; they have reported that the hypothesized Fourier differences increased sensitivity and decreased decision time. In the present work, multiple regressions were computed using differences in frequency and orientation to explain performance. It was found that 83 percent of d-prime and 74 percent of the decision time variance could be explained by the Fourier differences, indicating that physical measurement of symbols, i.e., their two-dimensional Fourier transform, may be used to predict the symbols' performance on a signal detection task. I.S.

#### A88-35476

##### FINE MOTOR CONTROL WITH CBR PROTECTIVE GLOVES

DEMETRIOS KARIS (Grumman Advanced Crew Station Laboratory, Bethpage, NY) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1206-1210. refs

The effect of wearing flight gloves or a combination of three gloves worn simultaneously for chemical, biological, and radiological (CBR) protection on the performance of a continuous cursor control task was investigated. Subjects sat in a cockpit mockup that is part of a reconfigurable crew-station evaluator, using their left ring finger on a two-axis force controller to move a cursor on a CRT. The time to acquire the target and the accuracy in centering the cursor over the target were recorded. It was found that subjects in either of the two glove conditions had faster acquisition times than the no-glove control subjects, with the same percent of errors. It is suggested that the thickness of the gloves may have improved the fit of the fingertip to the concave force controller, and also prevented the finger from slipping by increasing the coefficient of friction between the finger and the controller. I.S.

#### A88-35477

##### RESOURCES, CONFUSIONS, AND COMPATIBILITY IN DUAL AXIS TRACKING - DISPLAYS, CONTROLS, AND DYNAMICS

MARTIN L. FRACKER (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) and CHRISTOPHER D. WICKENS (Illinois, University, Urbana) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1211-1215. refs (Contract DAAA15-86-R-0046)

The quality of dual axis compensatory tracking was investigated as a function of the complexity of the control dynamics. Subjects performed single and dual-axis compensatory tracking tasks under one of 12 possible conditions formed from the factorial combination of three variables: (1) whether error displays were integrated (a single two-dimensional error cursor) or separated (two one-dimensional cursors); (2) whether controls for the two axes were separated or integrated into a single control; and (3) whether the dynamics on the two axes were both of the same order, or were different. It was found that separate displays led to greater tracking error. Integrated displays and controls both led to increased confusion between tracking axes, although the confusion did not lead to increased tracking error. Performance was affected when the integrality of displays did not match that of controls. The results suggest that dual axis tracking is subject to independent effects of resource competition, confusions, and Wickens' (1986) compatibility of proximity principle. I.S.

#### A88-35479

##### APPLICATION OF TULLIS' VISUAL SEARCH MODEL TO HIGHLIGHTED AND NON-HIGHLIGHTED TABULAR DISPLAYS

PRATAPRAY PAUL THACKER (Black and Veatch Engineers-Architects, Dunedin, FL), T. S. TULLIS (McDonnell

Douglas Astronautics Co., Huntington Beach, CA), and A. J. G. BABU (South Florida, University, Tampa, FL) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1221-1225. refs

This paper presents a comparison of experimental results with predictions obtained from Tullis' (1984) model of search times for tabular displays. Three levels of information density for displays with and without highlighting were used in a series of experiments. The highlighting of information was done by adding graphic boundaries (lines). Two levels of highlighting were used. A question-answer type of visual search was performed for two different tasks. The search time results are discussed and a method for utilizing Tullis' model for highlighted displays is suggested.

Author

#### A88-35480

##### A CONTRAST OF GUIDELINE RECOMMENDATIONS AND TULLIS'S PREDICTION MODEL FOR COMPUTER DISPLAYS - SHOULD TEXT BE LEFT-JUSTIFIED?

GAIL A. FONTENELLE (Rice University, Houston, TX) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1226-1228. refs (Contract MDA903-85-C-0347)

Two experiments investigated the effect of layout complexity for performance at varying levels of practice on four types of information extraction tasks. Layout complexity is defined as the number of unique horizontal and vertical starting positions of items in the display (Tullis, 1984). In the first study, layout complexity was manipulated by either left-justifying or not left-justifying text. In the second study, subject viewed a third experimental screen that displayed the starting positions of items in a completely unpredictable pattern. Moderate violations of the typical guideline recommendation that alphanumeric data be left-justified did not increase user search time across all four tasks in either the first or second study. Furthermore, severe violations of the recommendation did not increase user search time for three tasks (find label, scan data, and compare label). However, when subjects compared multiple data values, the random format did increase user search time. Though performance using the three experimental screens was comparable across the four tasks with only one exception, subjective ratings demonstrated differences between the three formats. Author

#### A88-35482

##### THE INFLUENCE OF COLOR ON VISUAL SEARCH AND SUBJECTIVE DISCOMFORT USING CRT DISPLAYS

MICHAEL L. MATTHEWS and KARIN MERTINS (Guelph, University, Canada) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1271-1275. Research supported by the Defence and Civil Institute of Environmental Medicine and Litton Systems Canada, Ltd; Department of Supply and Services. refs (Contract DSS-01SE-97711-6-8734)

Visual search and decision making performance together with subjective fatigue were investigated over a four-hour time block as a function of display foreground and background chromaticity, using colors matched for equivalent brightness. Although some small differences in performance related to chromaticity were observed, these were not exacerbated over time. On the basis of the performance data obtained and the subjective reports, there would appear to be no support obtained for the general recommendation to avoid the use of red and blue stimuli either alone or in combination in CRT displays. Author

#### A88-35487

##### ON-BOARD ELECTRONIC WARFARE SIMULATOR (OBEWS) - DESIGNING THE GROUND SUPPORT SUBSYSTEM (GSS) MAN MACHINE INTERFACE

GREGORY M. WILFORD (Science Applications International Corp.,

Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1296-1300.

This paper reports on the development of the On-Board Electronic Warfare Simulator (OBEWS) Ground Support Subsystem (GSS). The discussion will take place on two levels. At the top level, the theme of embedded training and the role that the OBEWS program will have in proving the feasibility of the concept will be discussed. At the second and more detailed level, the intensive human factors engineering effort undertaken in the design/development of the OBEWS GSS man machine interface (MMI) will be presented. A description of the resulting MMI will be included. The paper concludes with recommendations and lessons learned at both levels. Author

#### A88-35489

##### FIVE MACINTOSH TOOLS FOR HUMAN FACTORS ENGINEERING

CRAIG S. HARTLEY and JOHN R. RICE (Martin Marietta Corp., Denver, CO) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1306-1310. refs

This paper describes several applications of five Apple Macintosh software tools for uses in human-factors engineering. These five tools include the following programs: (1) Spreadsheet Task Analysis, a business-oriented software tool that was adapted to perform detailed human-factors task analysis; (2) Typeface Design Software, which is a selection of Macintosh typefaces that meet human-factors standards; (3) Expert System Screen Design Aid, an expert system development tool demonstrating a human-factors work aid; (4) Anthropometric Modeling, a software-based anthropometric drawings program that can be scaled to meet the designer's specific needs; and (5) Draw/Paint Programs and Databases, a data base of various controls, switches, displays, and other hardware components for mock-up representations and a collection of system hardware architecture drawings. I.S.

#### A88-35490

##### TEAM PERFORMANCE OF A DYNAMIC RESOURCE ALLOCATION TASK - COMPARISON OF SHARED VERSUS ISOLATED WORK SETTING

DENISE L. WILSON, MICHAEL D. MCNEESE (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH), and CLIFFORD E. BROWN (Systems Research Laboratories, Inc.; Wittenberg University, Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1345-1349. refs

The utility of shared versus isolated operator/display setting was examined in the context of a complex, dynamic, team decision making task. Both alphanumeric and graphic display formats were utilized as well as moderate and fast information presentation rates. Performance scores were significantly higher and subjective workload ratings significantly lower for the graphic display and moderate information rate conditions. No differences were found for shared versus isolated operator/display setting except in the combined 'worst case' condition of alphanumeric format and fast information rate, where a slight advantage was found for the shared operator/display setting. Author

#### A88-35493

##### COCKPIT AUTOMATION CONCEPT DEVELOPMENT FOR THE NUH-60 (STAR) AIRCRAFT

DANIEL D. RILEY and PAUL G. STRINGER (Essex Corp., Warminster, PA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1383-1387. refs

(Contract N62269-83-D-0115)

A study was performed to derive an automation and avionics integration design concept for the NUH-60 Systems Testbed for Avionics Research (STAR) aircraft. The STAR, a one-of-a-kind

reconfiguration of the UH-60 Black Hawk helicopter, is being developed by the U.S. Army Avionics Research and Development Activity to provide a flight demonstrator and research vehicle for state-of-the-art cockpit technology. The work was directed toward determining cockpit design preferences associated with single-pilot performance of the Army scout and utility missions. Emphasis was placed on high work load phases of the missions during which eyes-out-of-the-cockpit and hands-on-controls performance capabilities would be most crucial. A number of cockpit-based design alternatives in the areas of communication, navigation, aircraft survivability equipment operations, subsystem status monitoring, and aircraft performance computation and prediction were systematically derived and proposed. Author

#### A88-35494

##### THE APPLICATION OF HUMAN FACTORS TO THE DEVELOPMENT OF EXPERT SYSTEMS FOR ADVANCED COCKPITS

MICA R. ENDSLEY (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1388-1392. refs

This paper discusses the application of the processes, methodologies, and knowledge of the human-factors field to the development of AI expert systems for advanced cockpits. Following issues are addressed: the selection of systems to automate, the elicitation of expert knowledge from pilots, role allocation between the expert system and the pilot, system design criteria, and system evaluation. It is emphasized that the considerations of pilot work load, situation awareness, performance, and pilot acceptance are of primary importance to the successful design and implementation of a cockpit AI system. I.S.

#### A88-35495

##### THE COMPUTER-AIDED MAN-MODEL - A SAFETY VALVE IN HIGH TECHNOLOGY

JAN SNELL (Prime Computer, Inc., Marina Del Rey, CA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1393-1397.

The use of a computer-aided interactive human-factors modeling tool, the Prime Computer's System for Aiding Man/Machine Interaction Evaluation (SAMMIE), for evaluation of different cockpit design scenarios is demonstrated. SAMMIE enables the designer to create an environment representative of a work space, to manipulate the design entities to desired orientation in the three-dimensional space, to assess visibility, and to produce any crew population from appropriate anthropometric measurements. The man-model is then used to test specified priorities and conditions of the cockpit, such as the ease with which a certain instrument can be reached, the pilot's view at certain positions of the body and limbs, or the restrictions that must be put on the stick movements at certain altitudes and speed, to avoid a sudden increase of G force above the limit of G tolerance. I.S.

#### A88-35496

##### THREE-DIMENSIONAL AUDITORY CUE SIMULATION FOR CREW STATION DESIGN/EVALUATION

GLORIA L. CALHOUN, GERMAN VALENCIA, and THOMAS A. FURNESS, III (USAF, Harry G. Armstrong Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1398-1402. refs

A three-dimensional (3-D) auditory display can increase the pilot's situational awareness without requiring visual fixation. When visual acquisition is required, the directional sound can give the pilot a more rapid cue to aim the eyes or head. In order to determine the utility and performance of a 3-D auditory cues is required for simulation. Two laboratory systems are described which create, from monaural stimuli, binaural stimuli which can be perceived as localized and stabilized in space, regardless of the listener's head



position. Additionally, preliminary results of the localization performance with one approach are presented. Author

**A88-35497**

**PRACTICAL WORKLOAD ASSESSMENT IN THE DEVELOPMENT PROCESS**

JOHN B. SHAFER (IBM, Federal Systems Div., Owego, NY) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1408-1410. refs

This paper discusses a practical concept of work load measure, which makes it possible to assess this otherwise nonquantitative concept in terms of work-load units. In this practical approach, work load is considered as the number of activities modified by the level of difficulty, with the physical, mental, visual, vocal, or auditory activities counted and manipulated as things to do for a certain task. It is suggested that the level of difficulty is to be referred to the precision of a manual task, the confusion of a mental task, the ambiguity of a visual task, the verbal precision of a vocal task, or a low signal-to-noise ratio of an auditory task, and is to be rated by an approach suggested by McCracken and Aldrich (1983). The applications of the practical work-load concept by human-factor specialists to the development of an advanced helicopter is discussed. I.S.

**A88-35498**

**DEVELOPMENT OF A SYSTEM ENGINEER WORKSTATION**

WILLIAM J. HOFFMAN, JR. (FAA, Technology Center, Pomona, NJ), ANTHONY SALVADOR, and CHARLES J. THEISEN, JR. IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2. Santa Monica, CA, Human Factors Society, 1987, p. 1421-1424.

This paper describes the process of designing a system-engineer traffic control work station by using extensively human-factors engineering. The design approach was to have the human-factors experts guide and instruct the work station engineers in the development of a project. The project consisted of the integration of six different keyboards and a wide variety of display subsystems into a single keyboard and five displays. Special attention is given to the screen design process, to the functional operation of the CRT screens, and to the development of a command and control language. I.S.

**A88-35685**

**AN AUTOTRANSFUSION TECHNIQUE DERIVED FROM ANTI-G SUITS [UNE TECHNIQUE D'AUTO-TRANSFUSION DERIVEE DES COMBINAISONS ANTI-G]**

J. BERTRAND (Hopital Necker, Paris, France) and M. POISVERT (SAMU de Paris, France) (Societe Francaise de Medecine Aerospatiale, Meeting, Paris, France, Nov. 21, 1987) Medecine Aeronautique et Spatiale, vol. 26, 3rd Quarter, 1987, p. 192-196. In French. refs

Subdiaphragmatic circumferential pneumatic compression (SCPC), an autotransfusion method based on the anti-g suit, has been developed as a medical antishock technique. The three modes of operation of the device (autodiffusion, hematostasis, and the immobilization of subdiaphragmatic fractures) make it suitable for out-of-hospital application for patients suffering hemorrhagic shock. The technique can be used for blood losses up to 2.5 liters. Contraindications and precautions for use of the SCPC technique are given. The method also has application to the treatment of cardiac arrest. R.R.

**A88-35687**

**FLIGHT SUITS FOR THE CREWS OF NEW GENERATION COMBAT AIRCRAFT. I - GENERAL PRINCIPLES AND SLOW DECOMPRESSION TESTS [EQUIPEMENTS DE VOL POUR EQUIPAGES D'AVIONS DE COMBAT DE LA NOUVELLE GENERATION. I - PRINCIPES GENERAUX ET ESSAIS EN DECOMPRESSION LENTE]**

H. MAROTTE, H. VIEILLEFOND, and J. M. CLERE (Centre d'Essais en Vol, Bretigny-sur-Orge, France) (Societe Francaise de

Medecine Aerospatiale, Meeting, Paris, France, Nov. 21, 1986) Medecine Aeronautique et Spatiale, vol. 26, 3rd Quarter, 1987, p. 202-205. In French.

The general principles and the system structure of flight suits designed for the crews of new generation combat aircraft are discussed, and results of decompression tests are given. The suit is composed of standard anti-g pants, a pressurized vest, a partially pressurized helmet, and an inhale/exhale helmet valve. The suit provides protection against pulmonary overpressure due to explosive decompression. Slow decompression results obtained at altitudes up to 60,000 feet demonstrate the satisfactory functioning of the system. It is suggested from two incidents of pilot distress that the intrapulmonary pressure maintenance value employed was too high. R.R.

**A88-35688**

**FLIGHT SUITS FOR THE CREWS OF NEW GENERATION COMBAT AIRCRAFT. II - RAPID AND EXPLOSIVE DECOMPRESSION TESTS [EQUIPEMENTS DE VOL POUR EQUIPAGES D'AVIONS DE COMBAT DE LA NOUVELLE GENERATION. II - ESSAIS EN DECOMPRESSIONS RAPIDES ET EXPLOSIVES]**

H. MAROTTE, H. VIEILLEFOND, and J. M. CLERE (Centre d'Essais en Vol, Bretigny-sur-Orge, France) (Societe Francaise de Medecine Aerospatiale, Meeting, Paris, France, Nov. 21, 1986) Medecine Aeronautique et Spatiale, vol. 26, 3rd Quarter, 1987, p. 206-209. In French.

A previously described flight suit for combat aircraft crews was fitted with a mass-spectrometer gas-analyzer in the helmet in order to investigate the cases of both rapid and explosive decompression. The altimetric dilution system provided protection against hypoxia by inhalation of the air-oxygen mixture. The suit was shown to also provide protection against the effects of explosive decompression, high-g acceleration, and accidental immersion. The suit is found to function effectively up to a respiratory overpressure value of 100 hPa. R.R.

**A88-35698**

**THE CONCEPT OF PREVENTION IN AERONAUTICS: PSYCHOLOGICAL ASPECTS - THE MAN-(MAN-MACHINE)-ENVIRONMENT SYSTEM [LE CONCEPT DE PREVENTION EN AERONAUTIQUE: ASPECTS PSYCHOLOGIQUES - LE SYSTEME H/H-M/-E]**

G. VERON (Centre d'Etudes et de Recherches Psycho-Technique, Saint-Cyr l'Ecole, France) Medecine Aeronautique et Spatiale, vol. 26, 4th Quarter, 1987, p. 323-325. In French.

A man-(man-machine)-environment system approach to flight safety is presented which involves the determination of risk factors and the evaluation of the human factor. Human factors taken into consideration include cognitive ability, personality and motivation, and human limitations related to sleep and psychological state. The present systematic approach also takes the man-man interaction (social context) into account. Implementation of the approach involves both the development of well-adapted individual attitudes and the reinforcement of those attitudes through directives and counseling. R.R.

**A88-36631**

**A LITERATURE SURVEY OF THE HUMAN RELIABILITY COMPONENT IN A MAN-MACHINE SYSTEM**

KANG W. LEE (Electronics and Telecommunications Research Institute, Chung Nam, Republic of Korea), FRANK A. TILLMAN, and JAMES J. HIGGINS (Kansas State University, Manhattan) IEEE Transactions on Reliability (ISSN 0018-9529), vol. 37, April 1988, p. 24-34. refs

I.E.

**N88-20822\*# Charles River Analytics, Inc., Cambridge, Mass. IDENTIFICATION OF VISUAL EVOKED RESPONSE PARAMETERS SENSITIVE TO PILOT MENTAL STATE Final Report, Mar. 1985 - Aug. 1987**

G. L. ZACHARIAS NASA Apr. 1988 182 p

(Contract NAS1-17816)  
(NASA-CR-4140; NAS 1.26:4140; R8701) Avail: NTIS HC  
A09/MF A01 CSCL 05H

Systems analysis techniques were developed and demonstrated for modeling the electroencephalographic (EEG) steady state visual evoked response (ssVER), for use in EEG data compression and as an indicator of mental workload. The study focused on steady state frequency domain stimulation and response analysis, implemented with a sum-of-sines (SOS) stimulus generator and an off-line describing function response analyzer. Three major tasks were conducted: (1) VER related systems identification material was reviewed; (2) Software for experiment control and data analysis was developed and implemented; and (3) ssVER identification and modeling was demonstrated, via a mental loading experiment. It was found that a systems approach to ssVER functional modeling can serve as the basis for eventual development of a mental workload indicator. The review showed how transient visual evoked response (tVER) and ssVER research are related at the functional level, the software development showed how systems techniques can be used for ssVER characterization, and the pilot experiment showed how a simple model can be used to capture the basic dynamic response of the ssVER, under varying loads. Author

**N88-20823#** Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Psychology.

**MENTAL MODELS OF MECHANICAL SYSTEMS: INDIVIDUAL DIFFERENCES IN QUALITATIVE AND QUANTITATIVE REASONING**

MARY HEGARTY, MARCEL A. JUST, and IAN R. MORRISON  
Dec. 1987 36 p

(Contract N00014-85-K-0584; DA PROJ. RR0-4206)  
(AD-A189035; REPT-87-8-ONR) Avail: NTIS HC A03/MF A01  
CSCL 05H

People who understand mechanical systems can infer the principles of operation of an unfamiliar device from their knowledge of the device's components and their mechanical interactions. Individuals vary considerably in their ability to make this type of inference. This paper describes studies of performance in psychometric tests of mechanical ability. Based on subjects' retrospective protocols and response patterns, it was possible to identify rules of mechanical reasoning that accounted for the performance of subjects of different levels of mechanical ability. The rules are explicitly stated in a simulation model which demonstrates the sufficiency of the rules by producing the kinds of responses observed in the subjects. Three abilities are proposed as the sources of individual differences in performance: (1) ability to correctly identify which attributes of a system are relevant to its mechanical function, (2) ability to use rules consistently, and (3) ability to quantitatively combine information about two or more relevant attributes. GRA

**N88-20824#** Boeing Military Airplane Development, Seattle, Wash.

**MULTI-CREW PICTORIAL FORMAT DISPLAY EVALUATION  
Final Report, May 1984 - Jan. 1987**

T. C. WAY, R. L. MARTIN, J. D. GILMOUR, M. E. HORNSBY,  
and R. E. EDWARDS Mar. 1987 203 p

(Contract F33615-83-C-3618)  
(AD-A189349; AFWAL-TR-87-3047) Avail: NTIS HC A10/MF  
A01 CSCL 23B

The Multi-Crew Format evaluation was designed to evaluate pictorial formats in a two-seat fighter, to determine their usability as a function of color, and determine their acceptability. The study consisted of designing the formats, evaluation of formats in part-task, part-mission, and full-mission simulation, and redesigning formats based on air crew feedback if needed. GRA

**N88-20825#** Carlow Associates, Inc., Fairfax, Va.  
**ADVANCED HUMAN FACTORS ENGINEERING TOOL  
TECHNOLOGIES Final Report, 18 Jul. 1986 - 2 Apr. 1987**  
STEPHEN A. FLEGER, KATHRYN E. PERMENTER, and THOMAS

B. MALONE 20 Mar. 1987 276 p  
(Contract DAAA15-86-C-0064)  
(AD-A189390) Avail: NTIS HC A13/MF A01 CSCL 23B

Presented are the results of a study to identify the human factors engineering (HFE) technologies or tools presently used, and projected for use, by HFE specialists. Both traditional and advanced tools were candidates for inclusion in the report, although the emphasis of the study was on advanced computer applications. Human factors practitioners representing the government, the military, academe and private industry were surveyed to identify those tools most frequently used or viewed as most important for conducting human factors engineering related work. If advanced tool capabilities did not meet existing job requirements, the specialists identified the types of tools they would like to see developed to fill the existing technology gaps. The advanced tools were categorized using an eight point classification scheme, which included the phase(s) of the material acquisition process in which the tools' application would be most appropriate. All of the tools were ranked to facilitate tool selection, and entered into a database to accommodate future revisions. The survey resulted in the identification of 113 advanced human factors engineering tools. GRA

**N88-20826#** Georgia Inst. of Tech., Atlanta. Center for Man-Machine Systems Research.

**HUMAN PROBLEM SOLVING IN DYNAMIC ENVIRONMENTS.**

**UNDERSTANDING AND SUPPORTING OPERATORS IN  
LARGE-SCALE, COMPLEX SYSTEMS Final Report, Jun. 1982 -  
Dec. 1986**

RICHARD L. HENNEMAN and WILLIAM B. ROUSE Oct. 1987  
75 p

(Contract MDA903-82-C-0145; DA PROJ. 2Q1-61102-B-74-F)  
(AD-A189539; ARI-RN-87-51) Avail: NTIS HC A04/MF A01  
CSCL 05H

This research note seeks an empirical understanding of the relationship between the physical characteristics of a large-scale system and human performance and a formalization of empirical results into several measures of large scale complexity. Behavioral computer models of the human operator in a large-scale environment were then constructed, and the models were found consistent with human behavior. This approach showed subtle performance improvement for aided subjects. GRA

**N88-20827#** Douglas Aircraft Co., Inc., Long Beach, Calif.  
**PROCEEDINGS OF THE WORKSHOP ON THE ASSESSMENT  
OF CREW WORKLOAD MEASUREMENTS METHODS,  
TECHNIQUES AND PROCEDURES. VOLUME 1: PRELIMINARY  
SELECTION OF MEASURES Final Report, 24 - 25 Feb. 1987**

MICHAEL A. BIFERNO and GEORGE P. BOUCEK, JR. (Boeing  
Commercial Airplane Co., Seattle, Wash.) Jun. 1987 386 p  
Workshop held in Long Beach, Calif., 24-25 Feb. 1987

(Contract F33615-86-C-3600)  
(AD-A189004; AFWAL-TR-3043-VOL-1) Avail: NTIS HC A17/MF  
A01 CSCL 05H

The objectives of the workshop were to: gather information from workload experts regarding which measures have evidence supporting their reliability or validity; provide an independent review of the facts concerning the validity and reliability of workload measures; and provide a means for systematically reviewing and modifying the fact matrices. A schedule of the events is included. GRA

**N88-20828#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn  
(West Germany). Unternehmensgruppe Hubschrauber und  
Flugzeuge.

**PRESSURIZING SYSTEMS AND AIR CONDITIONING SYSTEMS  
[DRUCK- UND KLIMAAANLAGEN]**

SENONER 11 Apr. 1986 55 p In GERMAN  
(MBB/LKE-312/S/PUB/246; ETN-88-91440) Avail: NTIS HC  
A04/MF A01

The development of pressurizing and air conditioning systems for aircraft is outlined. The requirements for an air conditioning system are explained. The data and parameters for the design of

a pressurized air conditioning system are given. The investigations required for the design of such a system are outlined. The pneumatic supply units and subunits for pressurizing and air conditioning systems are described. The coolant processing unit, the air distribution system, and the heat transport cycle are described. The testing, problem solving, and improvement of pressurizing and air conditioning systems are explained. ESA

**N88-21638#** Anthropology Research Project, Yellow Springs, Ohio.

**FIT EVALUATION OF FEMALE BODY ARMOR Final Report, Jul. 1986 - Feb. 1987**

GREGORY F. ZEHNER, CAY ERVIN, KATHLEEN M. ROBINETTE, and PATRICIA DAZIENS Jun. 1987 63 p  
(Contract F33615-85-C-0531)  
(AD-A188721; AAMRL-TR-87-046) Avail: NTIS HC A04/MF A01 CSCI 05H

The object of this research was to evaluate the current issue MS-1 (Natick) female body armor vest, and to examine design modifications which would enhance the protection level by improving the fit. Subjects in the study were 37 female Air Force police trainees selected to represent a range of body sizes found in the overall USAF population. The MS-1 and two commercially available vests were evaluated for fit, comfort, and coverage in a series of measurements and observations. On the whole, the MS-1 vest compared favorable with the commercial garments. Some design changes are suggested to improve fit and coverage.

GRA

**N88-21639#** Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.

**MASKING OF MOTION CUES BY RANDOM MOTION: COMPARISON OF HUMAN PERFORMANCE WITH A SIGNAL DETECTION MODEL Thesis**

GLENN LEWIS GREIG Jan. 1988 343 p Sponsored by Natural Sciences and Engineering Research Council of Canada (UTIAS-313; ISSN-0082-5255) Avail: NTIS HC A15/MF A01

An investigation of human sensitivity to whole-body motion is described. Specifically, the ability of human subjects to detect a sinusoidal motion signal superimposed on a background of random motion is discussed. The purpose was to determine the conditions in which motion cues are masked or hidden by concurrent random motion. The results have applications to flight simulation, and will also be of interest to other researchers working in the area of human perceptual performance. It is proposed that for the situation under study, motion perception is a signal-in-noise detection process which can be modelled using signal detection theory. A brief review of signal detection theory is provided. Three ideal detectors adapted from the literature on auditory perception were proposed as potential models for motion perception. Three motion perception experiments were run. All three experiments provided an estimate of the slope of the psychometric curve. Of the three ideal detectors considered, the energy detector agrees best with the experimental data. The data are compared in detail with the predictions of the energy detector. A simplified method for estimating signal detectability in arbitrary conditions is presented. Finally, the implications of the results for flight simulation are discussed. Author

**N88-21640#** Transportation Systems Center, Cambridge, Mass.  
**ANALYSIS OF HEAD RESPONSE TO TORSO ACCELERATION. VOLUME 1: DEVELOPMENT OF PERFORMANCE REQUIREMENTS**

C. H. SPENNY Dec. 1987 182 p Sponsored by National Highway Traffic Safety Administration, Washington, D.C.  
(PB88-156757; DOT-TSC-NHTSA-86-5-VOL-1; DOT-HS-807-159-VOL-1) Avail: NTIS HC A09/MF A01 CSCI 05H

Performance requirements are developed which define the kinematic and kinetic response of the head for a seated subject exposed to frontal, lateral or oblique impact. Response is expressed in terms of variables which are readily measured in an anthropomorphic dummy and which are useful in injury prediction.

The performance requirements are based on volunteer tests in which a four-point restraint system and a singular type of impact profile are employed. Other tests are used to evaluate the effects of variation in impact profile, type of restraint system and level of muscle activity. Author

**N88-21641** National Physical Lab., Teddington (England). Div. of Information Technology and Computing.

**IMPROVING THE MAN-MACHINE INTERFACE TO ROBOTIC SYSTEMS**

D. R. MANNING, P. T. NEALE, R. E. RENGGER, and P. K. T. VASWANI Sep. 1987 31 p  
(NPL-DITC-100/87; ISSN-0262-5369; ETN-88-91911) Avail: National Physics Laboratory, Teddington, Middlesex, TW11 0LW, United Kingdom

Robotic and telerobotic systems are surveyed, emphasizing their control by human operator and their man-machine interface (MMI). Outstanding MMI problems are discussed and suggestions are made for future research in that area. Human operator control of manipulators is identified as meriting particular attention and the freehand control technique is explained. The development of a simple laboratory rig to demonstrate the principles of freehand control is described together with a qualitative assessment of experience gained with it. ESA

**N88-21642#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Inst. fuer Flugmedizin.

**PSYCHOPHYSICAL LOAD OF GLIDER PILOTS ON LONG-DURATION FLIGHTS Thesis - Bonn Univ.**

WOLFGANG KOLL Oct. 1987 113 p In GERMAN; ENGLISH summary  
(DFVLR-FB-87-38; ISSN-0171-1342; ETN-88-92110) Avail: NTIS HC A06/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000, Cologne, Federal Republic of Germany, 38.50 deutsche marks

In order to estimate pilot load on long duration flights, 9 glider pilots made 16 flights of up to 6 hours duration, mostly long-distance flights. There was continuous recording of the heart rate and flight protocol including altitude cockpit temperature and g-load. Tests to assess fatigue (self-rating) and performance were carried out at different times. There is no indication of continuous or sudden fatigue or any change of the performance level. Particularly risky situations excluded, the load of the cardiovascular system appears to be lower than previously assumed. ESA

**N88-21643#** Sandia National Labs., Albuquerque, N. Mex.

**HUMAN INTERFACES IN REMOTE DRIVING**

D. E. MCGOVERN 1988 33 p Presented at the IGC Conference, Bedford, Mass., 20 Mar. 1988  
(Contract DE-AC04-76DP-00789)  
(DE88-006843; SAND-88-0562C; CONF-880359-1) Avail: NTIS HC A03/MF A01

Driving vehicles through remote control (teleoperation) can allow the human operator to take actions at a distance. Human effectiveness can be projected into locations which may be hazardous. In order for the operator to control the motion of these vehicles, knowledge of the vehicle environment and status need to be available. This requires a system consisting of vehicle, communication link and human operator. Much work has been done in vehicle and communication system design but comparatively little effort has been devoted to the human interface. In this paper, experimental studies of remote driving are reviewed to approach an understanding of what is known. Summary data are presented for experimental work performed at Sandia National Laboratories in vehicle vision systems. This information is combined with the experience base developed through several years of work with teleoperated vehicles to identify the major areas requiring additional development effort. DOE

**N88-21644#** Royal Air Force Inst. of Aviation Medicine, Farnborough (England).

**FURTHER DEVELOPMENT OF A MATHEMATICAL MODEL FOR THE SPECIFICATION OF IMMERSION CLOTHING INSULATION**

P. A. HAYES and J. B. COHEN Mar. 1987 35 p  
(IAM-653; BR102902; ETN-88-92053) Avail: NTIS HC A03/MF A01

Changes to the FORTRAN code and method of use of the Wissler model of thermoregulation are discussed. Inclusions make possible the simulation of counter-current heat conservation processes, water leakage into dry suits, and alternative ways of distributing the subcutaneous fat thickness dependent on methods of measurement and calculation of the mean weighted thickness of fat. The way in which the model should be used to obtain reproducible and accurate simulations is discussed in relation to the production of survival curves used for the specification of immersion protection clothing assemblies. ESA

**N88-21645#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**IMPLEMENTATION OF A VISUAL SERVOING SYSTEM FOR EVALUATION OF ROBOTIC REFUELING APPLICATIONS M.S. Thesis**

MIKEL M. MILLER Dec. 1987 177 p  
(AD-A189676; AFIT/GE/ENG/87D-45) Avail: NTIS HC A09/MF A01 CSCL 12I

The threats of dangerous environments and projected cuts in military personnel, combined with advances in robotics and sensors, have caught the attention of the United States Air Force. The Flight Dynamics Laboratory at Wright-Patterson Air Force Base has been conducting research into concepts for performing aircraft ground refueling using robotic systems. The main sensor for a robotic refueler applications is vision. Visual information received from TV camera mounted to the refueling boom, provides the feedback data necessary for employing visual servo control techniques. This feedback data, the refueling port's centroid and depth, is used to visually guide the robot refueler to the refueling port. This research effort designs and integrates a visual servo control scheme for a PUMA 560 robot arm that derives its control information from a Machine Intelligence Corporation vision system. GRA

## 55

## SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

**A88-33119**

**INTERSTELLAR EXTINCTION BY COMETARY ORGANIC GRAIN CLUMPS**

F. HOYLE and N. C. WICKRAMSINGHE (University College, Cardiff, Wales) Astrophysics and Space Science (ISSN 0004-640X), vol. 140, no. 1, Jan. 1988, p. 191-203. refs

The observed features of the interstellar extinction curve in both the Galaxy and in the external galaxies LMC and SMC are explained on the basis of a model involving clumps of hollow or porous organic particles with an overall volume-filling factor of 0.1. The hollow organic particles have a ready explanation in terms of the bacterial grain model. The visual and near-infrared observations of extinction are fitted by a size distribution of such aggregates similar to the distribution law discovered for the larger grains in Halley's comet, but with a cutoff at low radii taken at 0.5 micron for the Galaxy and 0.3 and 0.4 micron, respectively, for SMC and LMC. Fine tuning of the theoretical extinction curve to fit observational data in the ultraviolet involves variable contributions from small condensed polymeric units of typical radius 0.012 micron and graphite particles of radii 0.02 micron. These particle species

may be regarded as being derived from the primary distribution of clumps. The implication is that cometary sources could provide a major component of the grains in interstellar space. Author

**A88-33120**

**A DIATOM MODEL OF DUST IN THE TRAPEZIUM NEBULA**

Q. MAJEED, N. C. WICKRAMASINGHE, F. HOYLE, and S. AL-MUFTI (University College, Cardiff, Wales) Astrophysics and Space Science (ISSN 0004-640X), vol. 140, no. 1, Jan. 1988, p. 205-207.

Measurements are reported of the 5-35 micron infrared spectrum of a mixed diatom culture dispersed in a Csl disc. These data are used to compute the flux from a diatom model of dust in the Trapezium nebula, where dust grain temperatures are assumed to be distributed in the range 230-130 K. Good agreement with the observational data is found for the model. Author

**A88-33549**

**MICROGRAVITY AND THE ORGANISMS - RESULTS OF THE SPACELAB MISSION D1**

D. VOLKMANN (Bonn, Universitaet, Federal Republic of Germany) Acta Astronautica (ISSN 0094-5765), vol. 17, Feb. 1988, p. 267-270. BMFT-supported research. refs

During the Spacelab mission D1 different organisms were investigated at the unicellular and multicellular level respectively. Microgravity affects growth and development of the organisms in a different manner, some processes are enhanced, others are inhibited. On the other hand, there are a lot of parameters, e.g. circadian rhythm or cell and organ polarity, which seem to be exclusively under genetical control. Author

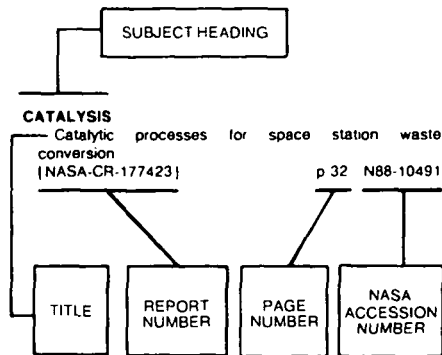
**A88-36127**

**ROLE OF TOPOLOGICAL LIMITATIONS IN THE KINETICS OF HOMOPOLYMER COLLAPSE AND IN THE SELF-ORGANIZATION OF BIOPOLYMERS [ROL' TOPOLOGICHESKIKH OGRANICHENII V KINETIKE KOLLAPSA GOMOPOLIMERA I V SAMOORGANIZATSII BIOPOLIMEROV]**

A. I. GROSBERG, S. K. NECHAEV, and E. I. SHAKHNOVICH (AN SSSR, Institut Khimicheskoi Fiziki, Moscow; AN SSSR, Institut Belka, Pushchino, USSR) Biofizika (ISSN 0006-3029), vol. 33, Mar.-Apr. 1988, p. 247-253. In Russian. refs

The dynamics of the collapse of a homopolymer chain after a sudden decrease of temperature or of solvent quality is discussed, with special attention given to the role of local topological factors. It is shown that, in a chain with contacting but topologically limited short nonself-penetrating sections, interpenetration could occur only by looping around, a process that would not lead to an increase in entropy and thus is not profitable thermodynamically. A folded-globule model is presented which qualitatively explains many properties of proteins and emphasizes the importance of topological limitations in the protein's self-organization. I.S.

### Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of document content, the title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

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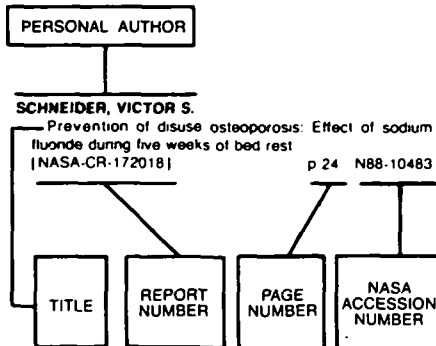
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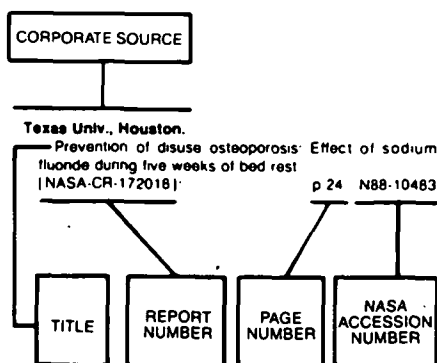
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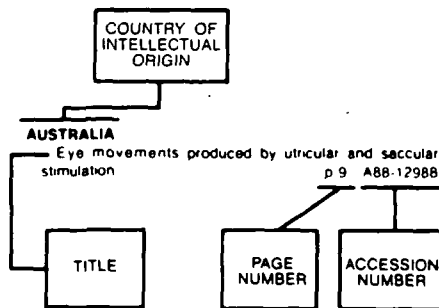


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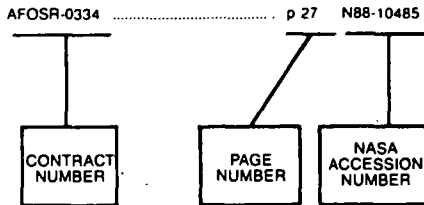
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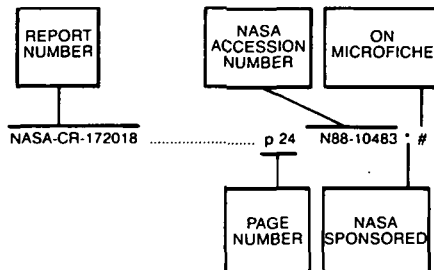
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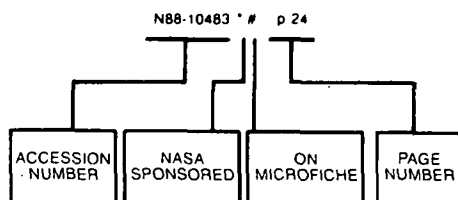
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## HAWAII

### UNIV. OF HAWAII LIBRARY

Govt. Documents Collection  
2550 The Mall  
Honolulu, HI 96822  
(808) 948-8230

## IDAHO

### UNIV. OF IDAHO LIBRARY

Documents Section  
Moscow, ID 83843  
(208) 885-6344

## ILLINOIS

### ILLINOIS STATE LIBRARY

Information Services Branch  
Centennial Building  
Springfield, IL 62756  
(217) 782-5185

## INDIANA

### INDIANA STATE LIBRARY

Serials Documents Section  
140 North Senate Avenue  
Indianapolis, IN 46204  
(317) 232-3686

## IOWA

### UNIV. OF IOWA LIBRARIES

Govt. Documents Department  
Iowa City, IA 52242  
(319) 353-3318

## KANSAS

### UNIVERSITY OF KANSAS

Doc. Collect—Spencer Lib.  
Lawrence, KS 66045-2800  
(913) 864-4662

## KENTUCKY

### UNIV. OF KENTUCKY LIBRARIES

Govt. Pub. Department  
Lexington, KY 40506-0039  
(606) 257-3139

## LOUISIANA

### LOUISIANA STATE UNIVERSITY

Middleton Library  
Govt. Docs. Dept.  
Baton Rouge, LA 70803  
(504) 388-2570

### LOUISIANA TECHNICAL UNIV. LIBRARY

Documents Department  
Ruston, LA 71272-0046  
(318) 257-4962

## MAINE

### UNIVERSITY OF MAINE

Raymond H. Fogler Library  
Tri-State Regional Documents  
Depository  
Orono, ME 04469  
(207) 581-1680

## MARYLAND

### UNIVERSITY OF MARYLAND

McKeldin Lib.—Doc. Div.  
College Park, MD 20742  
(301) 454-3034

## MASSACHUSETTS

### BOSTON PUBLIC LIBRARY

Government Docs. Dept.  
Boston, MA 02117  
(617) 536-5400 ext.226

## MICHIGAN

### DETROIT PUBLIC LIBRARY

Sociology Department  
5201 Woodward Avenue  
Detroit, MI 48202-4093  
(313) 833-1409

### MICHIGAN STATE LIBRARY

P.O. Box 30007  
Lansing, MI 48909  
(517) 373-1593

## MINNESOTA

### UNIVERSITY OF MINNESOTA

Government Pubs. Division  
409 Wilson Library  
309 19th Avenue South  
Minneapolis, MN 55455  
(612) 373-7870

## MISSISSIPPI

### UNIV. OF MISSISSIPPI LIB.

Documents Department  
University, MS 38677  
(601) 232-5857

## MONTANA

### UNIV. OF MONTANA

Mansfield Library  
Documents Division  
Missoula, MT 59812  
(406) 243-6700

## NEBRASKA

### UNIVERSITY OF NEBRASKA - LINCOLN

Love Library  
Documents Department  
Lincoln, NE 68588-0410  
(402) 472-2562

## NEVADA

### UNIVERSITY OF NEVADA LIB.

Govt. Pub. Department  
Reno, NV 89557-0044  
(702) 784-6579

## NEW JERSEY

### NEWARK PUBLIC LIBRARY

5 Washington Street  
Newark, NJ 07101-0630  
(201) 733-7812

## NEW MEXICO

### UNIVERSITY OF NEW MEXICO

Zimmerman Library  
Government Pub. Dept.  
Albuquerque, NM 87131  
(505) 277-5441

### NEW MEXICO STATE LIBRARY

Reference Department  
325 Don Gaspar Avenue  
Santa Fe, NM 87503  
(505) 827-3826

## NEW YORK

### NEW YORK STATE LIBRARY

Empire State Plaza  
Albany, NY 12230  
(518) 474-5563

## NORTH CAROLINA

### UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

Davis Library  
BA/SS Documents Division  
Chapel Hill, NC 27515  
(919) 962-1151

## NORTH DAKOTA

### UNIVERSITY OF NORTH DAKOTA

Chester Fritz Library  
Documents Department  
Grand Forks, ND 58202  
(701) 777-4629  
In cooperation with North  
Dakota State Univ. Library

## OHIO

### STATE LIBRARY OF OHIO

Documents Department  
65 South Front Street  
Columbus, OH 43266-0334  
(614) 462-7051

## OKLAHOMA

### OKLAHOMA DEPT. OF LIB.

Government Documents  
200 NE 18th Street  
Oklahoma City, OK 73105  
(405) 521-2502, ext. 252

## OKLAHOMA STATE UNIV. LIB.

Documents Department  
Stillwater, OK 74078  
(405) 624-6546

## OREGON

### PORTLAND STATE UNIV. LIB.

Documents Department  
P.O. Box 1151  
Portland, OR 97207  
(503) 229-3673

## PENNSYLVANIA

### STATE LIBRARY OF PENN.

Government Pub. Section  
P.O. Box 1601  
Harrisburg, PA 17105  
(717) 787-3752

## TEXAS

### TEXAS STATE LIBRARY

Public Services Department  
P.O. Box 12927—Cap. Sta.  
Austin, TX 78711  
(512) 475-2996

### TEXAS TECH. UNIV. LIBRARY

Govt. Documents Department  
Lubbock, TX 79409  
(806) 742-2268

## UTAH

### UTAH STATE UNIVERSITY

Merrill Library, U.M.C. 30  
Logan, UT 84322  
(801) 750-2682

## VIRGINIA

### UNIVERSITY OF VIRGINIA

Alderman Lib.—Public Doc.  
Charlottesville, VA 22903-2498  
(804) 924-3133

## WASHINGTON

### WASHINGTON STATE LIBRARY

Documents Section  
Olympia, WA 98504  
(206) 753-4027

## WEST VIRGINIA

### WEST VIRGINIA UNIV. LIB.

Documents Department  
Morgantown, WV 26506-6069  
(304) 293-3640

## WISCONSIN

### MILWAUKEE PUBLIC LIBRARY

814 West Wisconsin Avenue  
Milwaukee, WI 53233  
(414) 278-3065

### ST. HIST. LIB. OF WISCONSIN

Government Pub. Section  
816 State Street  
Madison, WI 53706  
(608) 262-4347

## WYOMING

### WYOMING STATE LIBRARY

Supreme Ct. & Library Bld.  
Cheyenne, WY 82002  
(307) 777-5919



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